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# TABULAR VIEW

OF THE

# PRIMARY DIVISIONS OF THE ANIMAL KINGDOM,

INTENDED TO SERVE AS

AN OUTLINE OF AN ELEMENTARY COURSE

OF

# RECENT ZOOLOGY

# (CAINOZOOLOGY),

OR THE

# NATURAL HISTORY OF EXISTING ANIMALS.

BY

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Fellow of the Royal Societies of London and Edinburgh; Fellow of the Royal College of Physicians of Edinburgh; Licentiate of the Royal College of Surgeons of Edinburgh (1814); late President of the Royal Medical Society of Edinburgh (1814); Honorary Member of the Royal Zoological Society of Ireland, of the Statistical Society of Paris, of the Medical Society of London, of the Literary and Philosophical Society of Leeds, &c.; Fellow (and formerly of the Council) of the Linnæan (1820), the Geological, and the Zoological Societies of London; Corresponding Member of the Medical Society of Athens, of the Royal Society of Sciences of Liege, of the Biological Society of Paris; Member of the Medico-Chirurgical, the Botanical, and the Royal Physical Societies of Edinburgh; late Lecturer on Comparative Anatomy at Edinburgh (1824); late Fullerian Professor of Physiology in the Royal Institution of Great Britain (1837); late Swineyan Lecturer on Palæozoology in connexion with the British Museum (1852); and Professor of Comparative Anatomy and Zoology in University College, London (since 1827).

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# ETERNITY OF SPECIES.

"The organs of nutrition and of relation, which we have been hitherto considering, enable the individuals of species, for a limited time, to live, to grow, and to feel; but while myriads of individuals appear and disappear, like passing shadows, in rapid succession, the species, or the typical forms of groups of animals, are still prolonged on the earth. The species, however, like the individuals which compose them, have also their limits of duration.

"The life of animals exhibits a continued series of changes, which occupy so short a period, that we can generally trace their entire order of succession, and perceive the whole chain of their metamorphoses. But the metamorphoses of species proceed so slowly with regard to us, that we can neither perceive their origin, their maturity, nor their decay, and we ascribe to them a kind of perpetuity on the earth.

"A slight inspection of the organic relicts deposited in the crust of the globe shows that the forms of species, and the whole zoology of our planet, have been constantly changing, and that the organic kingdoms, like the surface they inhabit, have been gradually developed from a simpler state to their present condition.

"These slow changes are regulated by the laws which preserve individual forms, and check the transmission, by generation, of modifications suddenly induced.

"Although no animal can exactly produce its like, the progeny are so nearly such, that, for all the purposes of science, we regard their forms as identical with those of the parent, and out of an indefinite series of such generations, and of individuals as nearly resembling them, we frame our organic species, and ascribe them to nature.

"All forms of matter appear to have a capability and a tendency to become organized, as all organic forms tend to higher stages of development, and chemical analysis shows the highest as well as the lowest forms of organic beings to consist of a complicated aggregate of mineral gases and liquids and solids. These organized aggregates once formed from their elements, all possess alike the means of transmitting their forms by generation, which is effected by the separation of a portion of their substance, when their own development is completed."—Grant, Lect. on Comp. Anat., Lect. 55th, 'Lancet,' 1833–34, vol. ii. p. 1001.

# CONTENTS.

# DEDICATION.

TO

## CHARLES DARWIN, ESQ., M.A., F.R.S.,

F.L.S., F.G.S., Acad. Cæs. Nat. Cur. Soc., etc.

Author of various Zoological Works.

Dear Mr. Darwin,

On public grounds, and as an old fellow-labourer in the same rich field of philosophic inquiry, I avail myself of the opportunity afforded in publishing this brief outline of the primary divisions of the Animal Kingdom, to dedicate these pages to you in testimony of my admiration and approval of your late successful attempt to throw further light on that involved and obscure question, regarded by some inquiring minds as the mystery of mysteries of organic nature, the origin of species by natural law; or, as you have more happily and more definitely expressed the problem, "the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life."

More than fifty years have now elapsed since the 'Zoonomia' of your illustrious ancestor, Dr. Erasmus Darwin, first opened my mind to some of "the laws of organic life," which he so clearly expounded, and so successfully applied to explain the abnormal phenomena of the human body; and nearly forty have already rapidly fled away since you and I were busied in exploring microscopically the delicate structures and the living phenomena of the lowest organisms abounding in the rich fauna of the Frith of Forth.

But while I have been humbly occupied with the gleanings of our fellow-labourers in the cabinets and seminaries of Europe, and reporting the results to my youthful auditors, you have been widely surveying the grand domain

of nature with a learned spirit over the oceans, seas, islands, and continents of the globe, in every latitude and in every clime, nearly from the one pole to the other, and accumulating that rich store of thought and observation which entitles you of all men to aspire to the complete solution of those great, though obscure problems of organic nature, which have so long perplexed philosophers; a labour which you have so successfully commenced, and in which you have already surpassed all your predecessors, from the time of Plato.

Intellectual triumphs like yours, which have been hailed with the assent and applause of all competent unbiassed minds at home and abroad, while they charm away the clouds of mysticism which overhang some parts of our science and of philosophy, and obscure the greatest truths of nature, alone add permanent glories to the annals of our country in the great struggle for intellectual pre-eminence and ascendency among the nations of the earth. With one fell sweep of the wand of truth, you have now scattered to the winds the pestilential vapours accumulated by "species-mongers" over every step of this ever-varying, ever-charming part of nature's works; and your next movement will dispel the remaining clouds of "mystical supernatural typical intrusions" which still hang on the horizon of the sublime prospect, now opening to the view, of the natural animalization of the orbs of space by the same simple laws which govern the physical and chemical phenomena with such wondrous harmony throughout the rest of the material universe.

I remain, my dear Sir,
With great respect and regard,
Yours most truly,
Robert E. Grant.

2 Euston Grove, Euston Square, London.
16th May, 1861.

# PREFACE.

This outline of the classification of existing animals is extracted from the manuscript notes of the more extended Course of Recent Zoology given in University College, with the view of its proving a useful accompaniment to the Student in the approaching Elementary Course, both as pointing out the exact order followed in the Lectures, and thereby directing him in the reading of other works, and as explaining by definitions some of the principal difficulties of nomenclature occasionally felt by beginners in the study of Zoology.

2 Euston Grove, London.
May 16, 1861.

# INTRODUCTION.

## 1. MATERIAL BODIES.

Our notion of the separate existence of an outward material universe rests chiefly on the causes of our various mental impressions being apparently independent of our consciousness itself, and seemingly inherent in some distinct common connecting substratum, exterior to the mind, independent of the will, and acting upon our consciousness through the medium of impressions made on the outward senses.

This outward substratum or material substance, the bond of all our varied sensations and ideas, thus inferred to occupy outward space, and to be perceptible by the medium of our senses, composes all the objects of the visible and tangible universe which alone it is the province of Natural History to investigate and describe, as far as their properties, phenomena, and laws of action can be revealed to us by the careful and legitimate use of our senses and faculties in the study of nature. To express more distinctly the relations of natural objects to each other, and to render more uniform and precise the language of their description, material bodies are divided into kingdoms, subkingdoms, classes, subclasses, orders, suborders, genera, subgenera, species, subspecies, varieties

and subvarieties; and these terms are never interchangeable, but reserved strictly scientifically and technically for the divisions to which they are respectively applied. Thus the material substances composing the entire system of outward nature are conveniently divided, according to their physical and chemical constitution, the properties they manifest, and the active forces with which they are endowed, into the mineral, the vegetable, and the animal kingdoms.

## 2. MINERAL KINGDOM.

Mineral bodies are unorganized, and exist in the solid, fluid, or gaseous condition, merely according to their temperature. Their ultimate chemical elements are mostly united in binary combinations; in structure they are homogeneous throughout; crystalline or amorphous; and they increase in bulk mechanically by the simple addition of similar matter to their surface. They do not live, or grow, or feel, or generate, or die; and their inherent active forces are chiefly manifested in the simpler phenomena of gravitation and chemical affinity. By the forces of gravitation and affinity the particles and masses of matter unite and combine to constitute the bodies diffused through cosmical space; and by recent experiments on the light emitted from distant luminaries, it is proved experimentally that their material constituents are the same as those of our earth, as was early conjectured by Newton from the universality of the laws of gravitation.

The force of gravitation as expressed by the weight of bodies is merely in the direct ratio of the quantity of material particles in their mass; but when united by chemical affinity, the kinds of forces acquired are always different from the mean of those of the combining atoms; and this acquisition of entirely new properties or forces is equally the universal result and the most certain test of their chemical union. Thus water, carbonic acid, and ammonia, are the most common mineral elements in nature; but when they chemically combine in favourable

conditions to form a particle of gelatine or albumen, the product no longer conducts itself as a mineral substance; and no limit can be discovered, theoretically or practically, to the new properties thus acquired by ternary and quaternary combinations of mineral elements.

By abandoning the legitimate path of philosophical inquiry, by adopting the ancient dogma of the inertia of matter, and by overlooking all familiar manifestations of material forces in the ordinary phenomena of nature, Plato was led to devise a hypothetical system of causation and supernatural agencies not discoverable by science, and to refer all striking results of natural laws to preconceived designs of his fancied agents. As it is easier to imagine than to discover, the general adoption of this error regarding the forces employed in the production of natural phenomena arrested the progress of science among the Greeks, and left the most important discoveries to a later period, when the proper interpretation of nature was resumed.

The cautious and careful scrutiny of the properties and conduct of particles and masses of matter in space has been rewarded by the discoveries of the laws of gravitation acting throughout the universe, the order of superposition of the stratified rocks composing the exterior crust of the globe, the law of definite proportions in chemistry, the law of storms, the conservation of the physical and vital forces, the origin of the animalization of our planet from the chemical union of the elements of organic nuclei, the laws of the migration of the earth's axis of rotation in terrestrial physics, the origin of all organic species by natural law, and many others, which have entirely revolutionized modern science, and greatly extended man's dominion over nature.

## 3. VEGETABLE KINGDOM.

Vegetable bodies are organized, or possess an internal arrangement of soft parts adapted for the transmission of fluid nutriment for growth by intussusception; and their ultimate chemical elements are mostly united in ternary

combinations. They are nourished only by mineral matter, which they chemically change, organize, and endow with vital forces; and their chief ultimate elements are carbon, oxygen, and hydrogen. Carbon is their predominant and characteristic element. In structure they are mostly cellular or vascular, without internal stomach or locomotive power, fixed and insensible. Their primitive cells possess a special internal lining of cellulose. They are not homogeneous throughout; and their differentiated parts perform special functions in the general process of nutrition. They decompose foreign mineral matter, and assimilate it to their own tissues. They live, grow, generate, and die. Heat and light are the principal known forces which act on the elements of plants; and under their animating influence they give out oxygen in respiration, assimilate carbon, and organize mineral matter for the food of animals. For the humble class of assimilative functions of plants, the higher animal endowments of consciousness and volition seem to be little required. Without an internal common receptacle of food, they absorb fluid nutriment through their roots, their general surface, or their leaves, and respire, circulate, and secrete by virtue of the vital endowments of their constituent cells. The latent vital forces of their complex organic elements are again restored at death by the formation of simpler mineral compounds, and by the evolution of heat, light, combustion, fermentation, and the development and animation of new cells, vegetable or animal, during their decomposition. They contribute also during life to the same conservation of forces, by the periodical shedding of leaves, flowers, secretions, fruits, bark, &c., as the moulting, the metamorphoses, and the ejectamenta of animals. Although the double layer of the ultimate vegetable cell and its contained fluid indicate a greater differentiation of structural parts than in the ultimate simple sarcodous cell of the animal, the vital manifestations and endowments of the latter already transcend those of the vegetable, and indicate the possession of a higher class of forces.

## 4. ANIMAL KINGDOM.

Animal bodies are organized for the internal assimilation of fluid organic matter, and are mostly endowed with the power of locomotion and the property of sensibility. Their ultimate chemical elements are commonly united in quaternary combinations; and their chief elements are nitrogen, oxygen, hydrogen, and carbon, nitrogen being their most characteristic constituent. They do not subsist on mineral matter, but are mostly furnished with an internal stomach for the reception and assimilation of organized substances, vegetable or animal. In their organization they have a preponderance of soft and fluid parts, which renders the balance of affinities among their multiple elements more easily disturbed, and their whole economy more pliant, mutable, and perishable. Like plants, they are nourished only with fluid matter transmitted through membranes, and always originate from the chemical union of fluid elements, never by evolution from indefinite ancestry. In respiration they consume oxygen and give out carbonic acid. They not only live, grow, generate, and die like plants, but also feel and move. The complex elements of the tissues of animal bodies, first elaborated in the vegetable kingdom and further metamorphosed in their own economy, are endowed with a higher class of vital forces, and adapted for the production of more varied and complicated living products, and living phenomena, than those of plants. The nuclei of their first formative cells, like all other products of animal growth and organization, originate *de novo* from their fluid organic elements, either in the infusions of organic matter in the exterior waters of the globe (*Monadinea*), or in the interior of bodies already organized (*Endocystica*), never by evolution from indefinite ancestry. The great proportion of soft and fluid parts in animal bodies, and their very complex chemical constitution, accelerate their decomposition after death, when they mostly return their elements to the simple binary compounds, gaseous, fluid, or solid, of the mineral kingdom, whence

they had passed into the plant. But a great part of their high vital forces, accumulated and latent in the living condition, or expended in maintaining that condition, now set free, manifest themselves in the production of heat, light, odorous emanations, and most of all in organizing and vivifying the nuclei of myriads of monadine animalcules in the act of their formation from their fluid organic elements.

## 5. ORGANIZATION OF ANIMALS.

An animal is an aggregate of living organized parts, harmoniously combined to effect, by their united actions, the nutrition, the locomotion, and the generation of the body. When some single determinate part of the body is specially appropriated and organized for a limited portion only of the complicated processes which constitute the life of an animal, it is termed an organ. When several organs combine to effect the processes of some complicated function of the economy, as digestion, circulation, or respiration, they constitute a system of organs. In the complex organisms of the highest animals the whole body is composed of many systems of organs, all acting harmoniously to the same end, the preservation of the individual and of the race. The organs composing the animal body are thus classified according to their functions, viz. :—First, Organs of Nutrition, or of Vegetative or of Organic Life (organs of, 1. Digestion, 2. Chylification, 3. Circulation, 4. Respiration, 5. Secretion, 6. Absorption, 7. Excretion); Second, Organs of Motion, or of Relation, or of Animal Life (organs of, 1. Support, 2. Attachment, 3. Action, 4. Sensibility, 5. Senses); Third, Organs of Generation, or of the Life of the Species (organs of, 1. Impregnation or Male Organs, 2. Conception or Female Organs).

But as we descend in the animal scale the internal structure simplifies, organs and systems of organs disappear, and at length every special organ and special function is entirely lost, and the simple soft gelatinous sarcode, alone

remaining, like a universal blastema, has, in every part of it equally, the potentiality of its own simple nutrition, motion, and generation.

The sum of the entire vital forees, however, which animate their various organisms for the production, not only of their intricate physical phenomena, but of their highest intelleetual manifestations, is always in the direct ratio of their general eomplexity of organization, or their stage of elevation in the animal scale. From this essential eonstitution and meehanism of the entire animal frame, it follows that the ehief characters of distinetion among individuals and groups of animals are mere struetural or morphological differentiations in aeeordanee with the ever-varying eonditions of their life.

## 6. CLASSIFICATION OF ANIMALS.

A methodical arrangement or classifieation of the animal kingdom, being designed to assist the memory, and to point out the natural relations of the objects to each other, should present to the mind, at least in the great primary divisions, some distinct, obvious, and important principle of association, and should therefore be founded on the modifieations of some one of the most influential organie systems of the economy; it should arrange animals nearly according to the degree of complexness of their general strueture, without violating the general affinities by which groups of animals are naturally connected with each other; it should eontain a proportionate number of divisions, of whatever grade, for the number of the objeets to be classified, and should distribute the objects in eonvenient proportion among the divisions adopted.

The motosensitive axis of the nervous system of animals is the source of the highest phenomena of animal life; it is the sole part of the animal body endowed with eonseiousness, or sensibility to impressions made upon it, and the chief eentre of the higher vital forces; it is most eonstant in its occurrence, and greatly modified in form, throughout

the animal scale; its modifications of form are well marked, they typify more than any other system the general form of the body, they closely accord with the grade of the entire organization of animals, and they are practically applicable for the establishment of primary divisions of the animal kingdom.

In the highest or vertebrated classes of animals—Mammalia, Aves, Reptilia, Amphibia, Pisces—the motosensitive nervous axis is in form of a brain and spinal cord, enclosed in a cranium and vertebral column, and they are thence termed Encephalia. In the molluscous classes of animals—Cephalopoda, Pteropoda, Gasteropoda, Lamellibranchiata, Palliobranchiata, Heterobranchiata—the nervous axis forms a single or double gangliated ring around the œsophagus, from which they are called Cyclogangliata. In the entomoid classes—Crustacea, Arachnida, Insecta, Myriapoda—the nervous axis forms a double longitudinal gangliated cord extending along the under part of the body, from which they are designated Diplogangliata. In the helminthoid classes—Annulata, Suctoria, Turbellaria—the nervous axis forms two parallel longitudinal approximated cords along the inferior part of the body, from which they have been called Diploneura. In the radiated classes—Echinodermata, Acalepha, Polypifera—the nervous axis is disposed as a circular cord around the entrance of the alimentary cavity; and they are thence denominated Cycloneura. And in the lowest, protozoic or sarcodous, classes of animals—Epitricha, Porifera, Foraminifera, Rhizopoda, Cystodia — where neither nerve-cell nor nerve-fibril is distinguishable, the seat of their apparent consciousness and the source of their distinct vital movements appears to be equally diffused through the granular flesh of the body, from which they are termed Acritoneura.

The history of existing animals belongs to Cainozoology, and that of extinct forms to Palæozoology. The existing races, which alone concern us here, are not descended from each other, although from more simple common ancestry, and they do not, therefore, form the links of a continuous

chain from the monad to man. They are all equally co-existent, independent, and unconneeted with each other, like the extreme peripheral buds of a tree of life, whose base is largely eoncealed or consumed in the earth, but whose more rceent branehes ean be readily traced through all the surviving fossiliferous strata of the globe. Sueh ramifying trees of life, however, have never eeased to originate and develope *de novo*, in the same mode as the first, sinee the first found a suitable habitat; and it is neither neeessary nor philosophieal to assume that any animal type had a different mode of origin from that of another, the durability of a type being the best proof of its natural origin. The so-named speeies of living animals, being thus unconneeted and independent, may here be arranged from the highest to the lowest forms, without violating any natural relations; but in palæozoology they might follow more naturally the descending line of their pedigree, from simple to complex, or from ancient to recent forms.

## First Subkingdom.

## VERTEBRATED OR ENCEPHALATED ANIMALS.

VERTEBRATA, *Cuvier* (ENCEPHALIA, *Grant*).

WITH brain and spinal cord enclosed in an osseous cranium and vertebral column; double and symmetrical organs of five distinct senses; red blood; a heart of two or more cavities; distinct respiratory and urinary organs; a biforate alimentary canal furnished with gastric cavity, liver, spleen, and pancreas, and not traversing the nervous axis; separate sexes; oviparous or viviparous generation; and great bilateral symmetry of the organs of animal life.

### First Class.

### MAMMALIA, *Linn.* MAMMALIANS.

Viviparous, air-breathing, warm-blooded, with heart composed of four cavities, free lungs suspended in a distinct thoracic cavity, skin pilose, and mammæ for lactation of the young after birth.

### First Subclass.

UNGUICULATA, *Ray* (ONYCHIOPODA, *Grant*).

Furnished with claws or nails on the hands and feet, fitting these members to minister to a higher intelligence in the prehension of food and the manipulation of the young; and with teeth for the most part entirely crowned with enamel, to suit them for soft aliment, principally of animal substance.

### First Order.

BIMANA, *Cuvier* (ERECTA, *Illiger*).

Thumbs long, free, and greatly opposable to the other

fingers on the hands. Inner toe of the foot large, strong for the support of the erect body, parallel with the other toes, and not opposable to them. Arms free at their articulation with the trunk, not serving for support, lateral in position, and pendent for extensive motion. Legs large, long, and strong for the support of the vertical frame; and feet not prehensile, arched, plantigrade, and broad to widen the base of support. Hands and feet pentadactylous. Trunk scantily pilose, anurous, and without ischiadic callosities. Incisor, canine, and molar teeth approximated, and adapted for soft food; no check-pouches. Large vaulted cranium, short restricted face and muzzle, and erect stature of the body, necessitated, and therefore produced, by the great size and weight of the brain. Mammæ pectoral, from the breadth of the chest, and the freedom of the arms for manipulating the young.

Man forms an isolated group, and convenient separate order of mammalians, from the well-marked structural adaptations of the feet for the entirely erect position of the body, and from no special character afforded by the head. The elephant and horse stand isolated among pachyderms to constitute two distinct orders (Proboscidea and Solidungula), exactly as man among the Primates of Linnæus.

### First Genus. Homo. Man.

Incisor teeth $\frac{4}{4}$, canines $\frac{1-1}{1-1}$, molars $\frac{5-5}{5-5}=32$. Teeth enamel-crowned, incisors vertical, canines short, and molars with rounded tubercles. Nails flat on the hands and feet; hair scanty, and chiefly confined to the head, face, axillæ, and pudenda. Arms short, reaching only to the middle of the femur. Hands highly prehensile, with fingers long, free, and flexible. Legs as long as the head and trunk, with articular adaptations for vertical station, and large extensor muscles of the joints. Face small and flat; forehead naked and vaulted; organs of the senses small and approximated. Brain and cranial cavity larger than in *Pitheci*; cerebral hemispheres more numerously and deeply

convoluted, more amply supplied with blood, and larger in proportion to the nerves issuing from it and to the weight of the whole body, but with no new part or organ. Eyes parallel, approximated and directed forward. Nostrils catarrhinous. Males larger and more pilose than the females. There are two pectoral mammæ; and the births are generally one or two.

First Species. *Homo sapiens*, Linn.

Fibres of the corpora pyramidalia forming cerebral hemispheres larger in every direction and more intimately united by commissures, than in *Pitheci*. Cerebral hemispheres externally trilobate, internally with tricornate lateral ventricles, and *ergot* or *hippocampus minor*, as in the higher quadrumana, and extending backwards, as in them, beyond the posterior edge of the cerebellum. Being thus more cerebrated, man is more intellectual and imaginative than other species, and less dominated by physical impulse. The mean weight of the brain to that of the whole body is nearly as one to thirty-six and a half. The facial angle ranges from about 70 to 90 degrees, and the mean duration of life between 70 and 80 years. From the structure of the larynx, tongue, and lips, they are well adapted for modulating the voice, and, like other mammalia, the races intercommunicate ideas and feelings by vocal sounds, expressions of features, gestures and attitudes, and have also invented means of accumulating and communicating knowledge by conventional signs of vocal sounds, unknown to lower species. In habits they are gregarious, polyphagous, social, slow, ambulatory, intelligent, migratory and cosmopolite. The aborigines of the great continents differ from each other in developmental characters which are structural, as in the nasal, malar, maxillary and other bones, and in slighter characters due to local conditions, as in the complexion, the hair, the stature, &c.

## Second Order.

## QUADRUMANA, *Cuvier* (Pollicata, *Illiger*).

The quadrumanous mammalians present the nearest approach to man in all their important structural relations, but have their articulations adapted for a semi-erect, climbing position of the body; and not only is the thumb opposable to the other fingers of the hand, but the inner toe of the foot is also opposable to the other toes, which are elongated and flexible to form a second pair of prehensile hands.

### *First Suborder.* Catarrhina, *Geoffr.*

Simiæ of the Old Continent, with narrow *septum narium*, nails flat on the hands and feet. In. $\frac{4}{4}$, can. $\frac{1-1}{1-1}$, mol. $\frac{5-5}{5-5}=32$, often cheek-pouches and ischiadic callosities.

Genera *Troglodytes* . . . . . *Mormon.*

### *Second Suborder.* Platyrrhina, *Geoffr.*

Simiæ of the New Continent, with broad *septum narium*, no cheek-pouches or ischiadic callosities, often prehensile tail, nails flat on the hands and feet. In. $\frac{4}{4}$, can. $\frac{1-1}{1-1}$, mol. mostly $\frac{6-6}{6-6}=36$.

Gen. *Mycetes* . . . . . *Leontopithecus.*

### *Third Suborder.* Strepsirhina, *Geoffr.*

Lemurs or makis of the Old World, with sinuous openings of the nostrils, muzzle elongated, nostrils terminal, teeth variable in number, insectivorous in character, fox-muzzled (*Prosimii* of Illiger), nails compressed, fur compact, mostly nocturnal.

Gen. *Indris* . . . . . *Galeopithecus.*

## Third Order.

## CHIROPTERA, *Blumenbach* (Volitantia, *Illiger*).

The bats have incisor, canine, and molar teeth approxi-

mated and enamel-crowned in both jaws, and the molars of insectivorous character. The arms and hands are greatly elongated and aliform, with cutaneous membrane extended between the fingers and between the arms and legs.

*First Suborder.* Pteropodida, *Grant.*

They are destitute of nasal membrane (anhistophorous), without tail (anurous), prominent-jawed (prognathous), and with three joints on the index finger.

Gen. *Pteropus* . . . . . *Macroglossa.*

*Second Suborder.* Noctilionida, *Grant.*

Anhistophorous, short-jawed (brachygnathous), with distinct tail (urodelous), with two phalanges on the index finger.

Gen. *Noctilio* . . . . . *Scotophilus.*

*Third Suborder.* Vespertilionida, *Grant.*

Anhistophorous, narrow-jawed (stenorhynchous), long-headed (macrocephalous), with only one phalanx on the index finger.

Gen. *Vespertilio* . . . . . *Plecotus.*

*Fourth Suborder.* Phyllostomida, *Grant.*

Nose furnished with membranous appendage (histophorous), and two phalanges on the index finger.

Gen. *Phyllostoma* . . . . . *Vampyrus.*

*Fifth Suborder.* Rhinolophida, *Grant.*

Nose furnished with complex membranous appendage in the form of a tuft (histophorous), head short (brachycephalous), muzzle broad, with only one phalanx on the index finger.

Gen. *Rhinolophus* . . . . . *Nycteris.*

## Fourth Order.

### INSECTIVORA, *Grant* (Carnassiers insectivores, *Cuvier*; Feræ insectivoræ, *Lesson*).

Incisor, canine, and molar teeth approximated and enamel-crowned in both jaws; tubercles of molar teeth sharp-pointed; no wings; feet and hands pentadactylous and plantigrade.

*First Suborder.* Brachycauloda, *Grant.*

With the canine teeth shorter than the front incisors in both jaws.

Gen. *Erinaceus* . . . . . *Condylura.*

*Second Suborder.* Macrocauloda, *Grant.*

Canine teeth much longer and larger than any of the incisors, in both jaws.

Gen. *Talpa* . . . . . *Setiger.*

## Fifth Order.

### CARNIVORA, *Grant* (part of Carnassiers carnivores of *Cuvier*; Chelopoda, *Goldfuss*).

Carnivorous terrestrial quadrupeds, with incisor, canine, and molar teeth enamel-crowned and securely fixed in deep alveoli. In. $\frac{6}{6}$, can. $\frac{1-1}{1-1}$, molars various; incisors small and close; canines largely prominent, and with deeply imbedded fangs; molars mostly acuminated to a single longitudinal cutting edge; hands and feet pentadactylous and furnished with large, compressed, curved claws, inner toe short on the hands and feet.

*First Suborder.* Plantigrada, *Cuvier.*

Resting the entire sole (planta) of the foot on the ground in progression, claws long and not retractile, habits slow, food various.

Gen. *Ursus* . . . . . *Mellivora.*

*Second Suborder.* Digitigrada, *Cuvier.*

In station or progression resting on the digits of the hands and feet, the plantæ raised from the ground; inner toe rudimentary on both pairs of feet, and claws mostly sharp and retractile; active, powerful, and predaceous.

Gen. *Mustela* . . . . . *Felis.*

*Third Suborder.* Palmigrada, *Grant.*

Claws when present sharp, not retractile; toes palmated by connecting integuments for wading or swimming; fur short and compact; conchæ rudimentary; habits semi-aquatic, piscivorous or carnivorous.

Gen. *Aonyx* . . . . . *Lutra.*

Sixth Order.

PINNIPEDIA, *Illiger* (Carnassiers amphibies, *Cuvier*).

Arms and legs in form of fins for swimming in the open seas, with proximal bones short, and toes elongated and webbed; the legs extended backwards in a line with the trunk; trunk much elongated, and tapered backwards, with smooth surface, and thick subcutaneous adipose layer; teeth variable; mostly piscivorous; habits oceanic and predaceous.

*First Suborder.* Phocida, *Grant.*

With incisor, canine, and molar teeth in both jaws.

Gen. *Calocephalus* . . . . . *Platyrhynchus.*

*Second Suborder.* Trichechida, *Grant.*

No incisor or canine teeth in the lower jaw; upper canines extending greatly downwards from the mouth; and molars with flat crowns adapted for mixed aliment.

Gen. *Trichechus.*

## Seventh Order.

### RODENTIA, *Grant* (Rongeurs, *Cuvier*; Glires, *Linnæus*).

Mostly phytophagous gnawing quadrupeds, with two chisel-shaped incisors in the front of the upper and the lower jaws; destitute of canine teeth in both jaws; molars with broad, flat crowns transversely laminated with ivory and enamel; movements and condyle of the lower jaw directed longitudinally; large vacant alveolar space between the incisor and molar teeth in both jaws; large abdomen, small thorax; large cerebellum, and movements rapid; feeble and gregarious. A few with pointed tubercles on the crowns of the molar teeth are predaceous and carnivorous.

*First Suborder.* Claviculata, *Fischer.*

With entire osseous clavicles articulated to the scapula and sternum, and allowing extensive and secure movements of the arms for prehension and climbing.

Gen. *Sciurus* . . . . . *Castor.*

*Second Suborder.* Subclaviculata, *Grant* (Nonclaviculata, *Fischer*).

With rudimentary clavicles, not articulated to the scapula or to the sternum, not securing the arms for climbing or prehension, but suiting them for digging and burrowing.

Gen. *Hystrix* . . . . . *Anœma.*

## Eighth Order.

### EDENTATA, *Cuvier.*

The varied terrestrial edentate quadrupeds are always destitute of teeth in the front of the mouth; they very rarely present an incisor tooth in either jaw, and some are entirely destitute of teeth above and below; mostly insectivorous or phytophagous; often with long narrow jaws

and tongue, large claws for digging, and scaly external covering; cranial cavity and brain small.

*First Suborder.* Brachyrhyncha, *Grant* (Brevirostres, *Latreille*).

Head rounded, muzzle very short, and incisors entirely wanting in existing species; neck long, and with false ribs anterior to the sterno-vertebral ribs; phytophagous, and furnished with long, curved, strong claws on hands and feet.

Gen. *Acheus* . . . . . *Bradypus.*

*Second Suborder.* Macrorhyncha, *Grant* (Longirostres, *Latreille*).

The muzzle elongated, conical and narrow; always insectivorous molar teeth in both jaws; very rarely incisor or canine teeth in either jaw; gape small, and tongue elongated and slender.

Gen. *Cachicama* . . . . . *Orycterpus.*

*Third Suborder.* Anodonta, *Grant.*

No incisor, canine, or molar teeth in either jaw; muzzle long and slender; gape very small, and tongue long, free, and filiform.

Gen. *Myrmecophaga* . . . . . *Manis.*

## Second Subclass.

### Ungulata, *Ray* (Hoplopoda, *Grant*).

The extremities of the digits on the hands and feet are invested with hard horny hoofs, which greatly diminish their functions as organs of prehension or of touch, and protect them from injuries of pressure or abrasion in their employment as mere organs of support while obtaining their simple vegetable food. The jaws are mostly elongated, with vacant spaces from deficiency of teeth on the fore

part, and largely occupied on the posterior parts with broad-crowned, complex molars, adapted for their vegetable aliment.

## Ninth Order.

### RUMINANTIA, *Cuvier* (Bisulca, *Illiger*; Pecora, *Lin.*).

Ruminating, bisulcate, eclaviculate, herbivorous quadrupeds, furnished with four distinct cavities of the stomach; mostly destitute of incisor teeth in the upper jaw, and furnished with eight incisors below.

#### *First Suborder.* Tubicornia, *Latreille.*

Tuberosities of the frontal bone covered with hollow, persistent, epidermic, dense horny sheaths. In. $\frac{0}{8}$, can. 0, mol. $\frac{6-6}{6-6}=32$.

Gen. *Mazama* . . . . . *Ovibos.*

#### *Second Suborder.* Plenicornia, *Latreille.*

Solid, osseous, mostly deciduous frontal horns in the male, and sometimes also in the female. Teeth: in. $\frac{0}{8}$, can. 0 (very rarely $\frac{1-1}{0}$), mol. $\frac{6-6}{6-6}$.

Gen. *Prox* . . . . . *Camelopardalis.*

#### *Third Suborder.* Ecornia, *Grant* (Inermia, *Latreille*).

No horns in either sex; always canine teeth above, generally also below; generally incisors $\frac{2}{6}$; stomach generally furnished with muscular water-cells; two toes, sometimes connected by a fold of the integuments.

Gen. *Moschus* . . . . . *Camelus.*

## Tenth Order.

### SOLIDUNGULA, *Illiger.*

Non-ruminant, eclaviculate, herbivorous quadrupeds, with simple stomach; quadrangular-prismatic, flat-crowned,

deeply fixed molars, and with the hands and feet terminated by a single undivided hoof.

Genus *Equus*.

### Eleventh Order.

### MULTUNGULA, *Illiger*.

Non-ruminant, non-proboscidian, eclaviculate, thick-skinned, phytophagous, pentadactylous quadrupeds, with two, three, or four toes covered with hoofs.

Gen. *Tapirus* . . . . . *Hippopotamus*.

### Twelfth Order.

### PROBOSCIDIA, *Grant* (Pachydermes proboscidiens, *Cuvier*; Pentadactyla, *Latreille*).

Thick-skinned, eclavicular, non-ruminant, phytophagous quadrupeds, destitute of canine teeth, with broad-crowned compound molars, incisors in form of large extended tusks, and with the nostrils greatly prolonged, in form of a conical, prehensile, muscular proboscis, supported in a deep intermaxillary fossa.

Genus *Elephas*.

## Third Subclass.

### Bipinnata, *Giebel* (Apoda, *Grant*).

Aquatic, naked-skinned, piciform, long-bodied mammalians, destitute of feet, with the arms in form of fins, the tail broad and extended transversely, and all the adaptations for a natatory oceanic life.

### Thirteenth Order.

### SIRENIA, *Illiger*.

Phytophagous, with flat-crowned molars for vegetable food, no canine teeth; body slightly pilose; hands elongated, with moveable fingers; rostrum short, nostrils terminal, and mammæ pectoral.

Gen. *Manatus* . . . . . *Halicore*.

## Fourteenth Order.

### CETACEA, *Ray*.

Zoophagous; surface smooth, without hair; hands small, short, and fingers immoveable; rostrum elongated, and nares opening on the vertex of the head; teeth conical and similar, placed alternately, prehensile, often numerous, sometimes nearly or entirely deficient; mammæ simple in structure and inguinal in position.

Gen. *Delphinus* . . . . . *Balænoptera*.

## Fourth Subclass.

### DIMETROA (*μητρα, uterus*), *Grant*.

The dimetröal terrestrial quadrupeds have always the cavity of the uterus completely divided, throughout its whole extent, into two separate canals, which have no communication with each other. The fœtus is never attached by placenta to the interior of the uterine cavities. There are always marsupial bones in both sexes, attached to the pubies, and most generally a distinct external sub-abdominal marsupial sac for containing the mammæ, and protecting the abortive young after their premature birth. They present many oviparine affinities in the organs and functions of the generative system, and in those of animal life.

## Fifteenth Order.

### MARSUPIALIA, *Cuvier* (DIDELPHES, *Linnæus*; MASTOTHECIA, *Grant*).

Provided with an external abdominal pouch containing the mammæ, and serving to protect the young during lactation. The two uteri membranous; generation implacental and abortive; vagina partially divided, and often also the male organ.

*First Suborder*. Sarcophaga, *Grant*.

Pouched, carnivorous, digitigrade quadrupeds, with inc. $\frac{8}{6}$,

small, close, and vertical; can. $\frac{1-1}{1-1}$, large, conical, and prominent; molars with single longitudinal cutting crowns and inner tubercle at their base; body muscular and strong; movements slow; habits predaceous; stomach always simple; no cæcum-coli.

Gen. *Thylacinus* . . . . . *Phascogale.*

*Second Suborder.* Entomophaga, *Grant.*

Pouched; insectivorous; incisors various, can. $\frac{1-1}{1-1}$, prominent; molars broad-crowned, with pointed tubercles; stomach always simple; long cæcum-coli; feet prehensile, scansorial or natatory, sometimes aliform cutaneous expansions between the arms and legs for flying.

Gen. *Didelphis* . . . . . *Petaurista.*

*Third Suborder.* Phytophaga, *Grant.*

Pouched, phytophagous quadrupeds, with two long proclivous incisors in the lower jaw, with broad-crowned molars presenting alternations of ivory and enamel, and always destitute of canine teeth in the lower jaw. Abdominal cavity and alimentary organs large; stomach capacious, sometimes sacculated and complex, and sometimes furnished with large lobulated cardiac glands; colon sometimes provided with both cæcum and vermiform appendix; generally large claws, especially on the hind feet.

Gen. *Hypsiprymnus* . . . . . *Phascolomys.*

Sixteenth Order.

MONOTREMA, *Geoffr.*

No abdominal pouch, nor divided vagina; distinct marsupial bones in both sexes; two exposed multiforate ventral mammæ; testes confined to the abdomen, and male organ concealed in a prepucial cavity, as in oviparous vertebrata; but one common external opening, in both sexes, for the urinary, the genital, and the alimentary organs, as in birds and reptiles, and the right genitals of the female imperfectly

developed as in birds; habits insectivorous, and entirely without fanged or osseous teeth.

*First Suborder.*

Stenorhyncha, *Grant* (Macroglossa, *Latreille*).

Terrestrial, spiny-skinned; entirely destitute of teeth; small mouth, and long vermiform tongue; elongated, narrow, tapering muzzle, and large, strong claws, adapted to dig for insect food.

Genus *Echidna*.

*Second Suborder.*

Platyrhyncha, *Grant* (Pinnipeda, *Latreille*).

Aquatic, soft-furred, web-footed; no incisor or canine teeth, molars $\frac{2-2}{2-2}$, mere thin horny crowns; gape wide, lips sensitive; lower mandible serrated, broad, depressed, flat; duck-billed muzzle; sharp curved claws on the hands and feet; fingers and toes largely palmated, to obtain their insect food in the waters.

## Second Class.

## AVES. BIRDS.

Oviparous, warm-blooded, feathered, with wings for flight and legs for stationary support; ova hatched by incubation; heart with four cavities, and respiration by fixed lungs and by systemic air-cavities.

First Order.

### RAPACES.

Rapacious, powerful, muscular, with strong, dense, compressed, arched bills; upper mandible large, hooked, overarching the lower, and furnished with naked coloured cere; neck and legs short and muscular, and with large crooked retractile claws on all the toes.

Gen. *Falco* . . . . . *Strix*.

Second Order.

## OMNIVORÆ.

Omnivorous, with bills conical, dense, and sharp-edged; toes free, three forwards and one backwards; wings moderate; quill-feathers pointed; migrations limited.

Gen. *Corvus* . . . . . *Paradisea.*

Third Order.

## INSECTIVORÆ.

Insectivorous, with straight, slender, narrow bills, rounded and finely pointed, and with coarse hairs directed forwards at their base; toes three before and one behind, articulated on the same plane, and the middle toe united to the outer as far as the first articulation; inferior larynx with three pairs of strong muscles; voice powerful and musical.

Gen. *Lanius* . . . . . *Anthus.*

Fourth Order.

## GRANIVORÆ.

Granivorous, with thick, short, strong, conical-pointed bills; toes three before and one behind, free to their base; with considerable crop and muscular gizzard; voice powerful, musical, and migrations extensive.

Gen. *Alauda* . . . . . *Ploceus.*

Fifth Order.

## ZYGODACTYLI.

Zygodactylous, scansorial, with toes in pairs, two forwards and two backwards; coarse or hard vegetable food, and large strong bills, very rarely animal food.

Gen. *Picus* . . . . . *Musophaga.*

## Sixth Order.

## ANISODACTYLI.

Anisodactylous, scansorial; toes three before and one behind, base of the outer and middle toes closely united by integuments; with long, crooked, sharp claws; long, slender, narrow, pointed bill, and insect food.

Gen. *Sitta* . . . . . *Ornismya.*

## Seventh Order.

## ALCYONES.

Insectivorous and piscivorous, with long pointed bills; the three anterior toes connected at their base; tarsi very short; large wings, rapid flight.

Gen. *Alcedo* . . . . . *Momotus.*

## Eighth Order.

## CHELIDONES.

The swallow tribe have the bill very broad at the base, very depressed, short, feeble, with upper mandible curved at the point; legs short, claws much curved and sharp; wings very long, flight rapid and abrupt; food insects, migrations extensive, habits constructive.

Gen. *Hirundo* . . . . . *Steatornis.*

## Ninth Order.

## GALLINÆ.

Large, heavy, vegetable-eating birds, with short, strong, convex bill, covered at its base with a broad cere, in which the operculated nostrils open laterally; anterior three toes united at their base, and posterior toe higher on the metatarsus; feet coarsely scaled, and claws short and strong for rasorial habits; wings short and feeble, with limited flight.

Gen. *Columba* . . . . . *Alectheli.*

Tenth Order.

ALECTORIDES.

Large, strong, extra-European, long-legged, herpetophagous and entomophagous birds, with strong prehensile feet, and generally short rapacious bills; hind toe higher on the metatarsus; wings powerful for sustained flight, and legs muscular for cursorial habits.

Gen. *Psophia* . . . . . *Gypogeranus.*

Eleventh Order.

CURSORES.

Large, heavy, phytophagous, cursorial birds, with long muscular limbs, destitute of feathers nearly to the knees, and small feeble wings, unsuited for flight; three or two toes directed forwards, none behind; the bill generally short, feeble, with sharp edges for cutting or pecking vegetable substances.

Gen. *Struthio* . . . . . *Apteryx.*

Twelfth Order.

GRALLATORES.

With long, slender, naked legs, adapted for wading; short femur, long tibia and metatarsus, and long, free, divergent toes; three toes before, with only rudimentary webs, and one smaller behind; neck long and slender; head short, with long, compressed, straight, conical, sharp-pointed bill, suited for darting on prey in the waters, and with long powerful wings for extended migrations.

Gen. *Grus* . . . . . *Chionis.*

Thirteenth Order.

PINNATIPEDES.

Short-legged, natatorial, piscivorous birds, with the sides of the toes pinnated with rudimentary webs; legs articu-

lated far back on the trunk, tarsi compressed, posterior toe small, and higher on the metatarsus; bill moderate, straight; plumage short, soft, and compact.

Gen. *Porphyrio* . . . . . *Podiceps.*

### Fourteenth Order.

### PALMIPEDES.

The swimming birds have three toes, directed forwards, long, strong, divergent, and connected by thick folds of the integuments to near their extremities; the legs are short, strong, and attached near the posterior end of the trunk, and with short obtuse claws on the toes; the neck and bill generally long, with a hooked extremity of the upper mandible; the mandibles often broad, depressed, soft and sensitive; and plumage soft, compact, downy, with oiled surface to resist the permeation of water; mostly zoophagous, with powerful flight and extensive migrations.

Gen. *Sterna* . . . . . *Aptenodytes.*

## Third Class.

## REPTILIA. REPTILES.

Cold-blooded, oviparous animals, with three cavities of the heart, breathing solely by lungs, with one occipital condyle, with hyoid and lower jaw separately articulated to the cranium; covered externally with horny scales; having the embryo provided with amnion and allantois; and never possessing branchiæ at any period of life.

### First Order.

### CHELONIA.

Chelonian reptiles have always the ribs articulated immoveably with the vertebræ, and with each other; their trunk is invested by a *carapace* above, formed by the ribs and vertebræ, and by a *plastron* below, formed by the

sternum; and they have always both arms and legs adapted for ambulatory or natatory progression. They are comprehended under the suborders Carettida, Testudinida, and Emydida.

### Second Order.

### SAURIA.

Saurian reptiles have always the ribs united to the vertebræ by moveable articulations, and the margins of the ribs are free; the sternum and the sternal ribs are also moveable; and they are always provided with arms and legs, or with one pair of these extremities. They are comprehended under the suborders Crocodilida, Lacertida, Pteropodes, Nexipodes, and Mastodontia.

### Third Order.

### OPHIDIA.

Ophidian reptiles or serpents are destitute of arms and legs, and have the ribs articulated moveably with the vertebral column. They have very numerous, short vertebræ, with bodies deeply concavo-convex; no sacrum, nor cervical region, nor sternum, and rarely present the rudiments of a scapular or a pelvic arch. The anterior ends of the ribs, being free and connected with the skin and the abdominal scuta, serve as organs of locomotion. They compose the suborders Anguinida, Ilysida, Pythonida, Colubrida, Bungarida, Viperida, and Crotalida.

## Fourth Class.

## AMPHIBIA.

The amphibians or batrachians are cold-blooded, oviparous animals, with three cavities of the heart; furnished with effective lungs, which undergo metamorphosis; have the surface of the skin naked, have two occipital condyles,

are destitute of claws on the hands and feet, have not the hyoid and lower jaw articulated separately to the cranium, have not the embryo furnished with amnion or allantois, and breathe in the young state by distinct branchiæ.

First Order.

CADUCIBRANCHIA.

Breathe by free external branchiæ in the larva state, which they lose during the metamorphosis, and never possess a rudiment of gills in the adult. Most are anurous, or tailless, in the adult state (Suborder 1. Ranida) ; others are urodelous, or retain a distinct tail after the metamorphosis (Suborder 2. Salamandrida), along with webless hands and feet ; and others are destitute of extended tail, and of every rudiment of arms or legs (Suborder 3. Cæcilida).

Second Order.

PERENNIBRANCHIA.

Possess distinct branchiæ in the adult, fitting them for a permanent aquatic life ; tail always long, compressed, pinniform, expanded vertically as in fishes ; generally small, digitated atlantal and sacral extremities ; rarely arms alone ; and they are never apodal. Their lungs and tracheæ are simple membranous sacs, as common in fishes. Those with four feet, as the Proteus and Axolotl, compose the Suborder Tetrapoda ; and those with only the two anterior feet form the Suborder Dipoda.

Fifth Class.

PISCES. FISHES.

Cold-blooded, oviparous, branchiated animals, with one auricle and one ventricle of the heart ; not undergoing metamorphosis, covered with scales, and having the arms

and legs constructed as fins for a permanent residence in the waters. Their rudimentary lungs are very rarely employed for breathing, generally for regulating their specific gravity. They mostly impregnate the ova externally; and there is no amnion or allantois in the ovum.

### First Order.

### NEMATOPTERI, *Grant* (Sirenoidei, *Müller*; Protopteri, *Van der Hoeven*).

Breathing both by branchiæ and lungs; auricle partially divided, and receiving both venous and arterial blood; blood-corpuscles very large; lungs double, slightly cancellated, and capable of furnishing vocal sounds; four internal branchiæ, and small rudiments of external; cranium articulated to the atlas as in fishes; body covered with scales; skeleton cartilaginous and green coloured; bodies of the vertebræ continuous, undivided and tubular, and chorda dorsalis persistent; labyrinth of the ear imbedded in the temporal bone; nostrils laminated, and furnished with posterior nares; pectoral and ventral fins long and filiform, and furnished with minute rudimentary rays and connecting membrane; distinct spleen, liver provided with gall-bladder, and intestine with spiral valve.

Genus *Lepidosiren*.

### Second Order.

### CHONDROPTERYGII, *Cuvier*.

Skeleton cartilaginous, with partial granular ossification, and few divisions into separate bones; mouth inferior, broad, not terminal; branchiæ pectinated, mostly fixed at their outer margin, generally more than four pairs, and opening by numerous, separate, inopereulated, cutaneous apertures; cerebral hemispheres large, with lateral ventricles, and large suleated cerebellum; ventricle of the heart broad and depressed, with longitudinal rows of valves in

the bulbus arteriosus; pancreas conglomerate; intestine with spiral valve, and rudimentary cæcum-coli.

Gen. *Scyllium* . . . . . *Chimæra.*

## Third Order.

## ACANTHOPTERYGII, *Cuvier.*

Skeleton osseous and fibrous, and cranial bones separated by distinct sutures, mostly squamous; intermaxillary, superior maxillary, palatine, and tympanic bones freely moveable. The body mostly covered with broad, imbricated, coloured, calcareous scales; generally furnished with large median fins, and always with a large vertical caudal fin. Fins generally supported with strong osseous rays. When more than one dorsal fin is present, the first or anterior of these is entirely supported by osseous rays; and when the dorsal fin is single, the first rays are always spinous. The first rays of the anal fin are always spinous, and there is generally one spinous ray at the beginning of each ventral fin. The cerebral hemispheres are generally smaller than the optic lobes, and without internal ventricles; the cerebellum small, and without transverse sulci. The internal ear is not imbedded in the temporal bone; the nasal cavities are without posterior openings. The intestine is without spiral valve, and the pancreas is merely follicular. Ventricle of the heart mostly pyramidal in form, and four pairs of pectinated, free-edged branchiæ, communicating externally by a single operculated opening. Species mostly oceanic and predaceous.

Gen. *Perca* . . . . . *Fistularia.*

## Fourth Order.

## MALACOPTERYGII.

Skeleton osseous and fibrous; bones of the mouth freely moveable; body mostly compressed, covered with large scales, and internal organs of lower type. All the fins

supported by soft-jointed and cleft rays, excepting sometimes the first ray of the dorsal and pectoral fins. Intestine without spiral valve; fewer pyloric pancreatic follieles; heart pyramidal; and branchiæ peetinated, with single operculated opening. Most phytophagous, and inhabiting fresh waters.

Gen. *Cyprinus* . . . . . *Ammodytes.*

## Fifth Order.

## LOPHOBRANCHII.

Skeleton imperfectly ossified and fibrous; bones of the mouth freely moveable; body covered with hard cutaneous plates and spines, giving it an angular form; branchiæ in form of ramified round tufts, attached along the branchial arches, and disposed in regular pairs under a large operculum, with small opercular opening. Small, feeble, marine fishes, with large thin air-sac, without pectinated gills, and destitute of pylorie pancreatic cæca.

Gen. *Syngnathus* . . . . . *Pegasus.*

## Sixth Order.

## PLECTOGNATHI.

Bones of the skeleton soft, loose, but distinctly fibrous; branchiæ peetinated, operculated, and uniforate; intermaxillary, superior maxillary, and palatine bones fixed as in mammalians, leaving the lower jaw alone moveable; ribs rudimentary, no ventral fins, no panereatie cæca; capacious alimentary canal, and large air-sac; teeth mostly united into continuous plates, and often large œsophageal pouch; skin often furnished with spines or plates; and swim with facility near the surface of the sea.

Gen. *Diodon* . . . . . *Ostracion.*

### Seventh Order.

### CYCLOSTOMI.

Mouth surrounded with expanded museular suetorial disk, formed by the united, slender, cartilaginous jaws, and often supporting numerous horny teeth, or marginal filiform tentaeula, or long vibratile eilia. The skeleton is mostly composed of the softest cartilage, sometimes of mere fibrous membrane, and is the most rudimentary of all vertebrate forms. No pectoral or ventral fins, or seapular or pelvic arches. The vertebræ compose a simple fusiform tube, and the ehorda dorsalis continues large and uniform throughout the eolumn. Body elongated, vermiform, eylindrical, or slightly eompressed, and tapered to either end. In the highest forms the intestine passes straight through the body, and is furnished with an internal spiral valve, as in the plagiostomes; and their pectiniform branehiæ are fixed at their outer edges, and open by several orifiees along the sides of the neek. They eompose the Suborders Lampretidi, Myxinoides, and Amphioxidi or Leptocardii, the lowest type of all the Vertebrate Subkingdom.

## Second Subkingdom.

## MOLLUSCOUS OR CYCLOGANGLIATED ANIMALS.

### Mollusca, *Cuvier* (Cycloganglata, *Grant*).

The body possesses no internal osseous skeleton, and is most commonly invested with an external laminated ealcareous shell. The eerebro-spinal or senso-motory axis of the nervous system is not eolleeted into an aggregate mass enclosed in a eranium and vertebral eolumn, and placed entirely above the alimentary eanal, as in vertebrata; but forms a more detaehed series of ganglia disposed eireularly around the œsophagus. The trunk of the body is not articulated, nor possesses articulated members, nor red blood,

nor exterior investment of scales, hairs, spines, or feathers, nor tubular-jointed deciduous crusts. The body is generally short and broad, covered with a soft, naked skin, furnished with unarticulated tentacula, nourished with colourless blood, and provided with a systemic heart, consisting of two cavities, and with branchiæ adapting them for an aqueous life.

## Sixth Class.

## CEPHALOPODA, *Cuvier.*

The cephalopodous mollusks have tentaculiform, prehensile, locomotive feet disposed around the head, a musculocutaneous mantle investing the abdomen, and open anteriorly, and symmetrical, leaf-life branchiæ suspended freely in the open cavity of the trunk. The body is mostly naked, sometimes contained in an open, inoperculate, polythalmous or monothalmous, calcareous shell, and sometimes is furnished with an internal subcutaneous, horny or testaceous dorsal rudiment. They possess a distinct head, supporting symmetrical organs of the five senses, and containing a rudimental cartilaginous cranium, through which the œsophagus passes, surrounded by the cephalic ganglia. They are entirely marine, predaceous, endowed with the highest organization of all invertebrata, and have the nearest affinities to fishes.

### First Order.

### ACETABULIFERA, *Férussac* (Cyathophora, *Grant*).

The muscular arms surrounding the head support numerous circular prehensile suckers (acetabula), by which they adhere more firmly to the surfaces to which they are applied. The body is very rarely furnished with a testaceous covering, and when present is always monothalmous. The heart is partly branchial and partly systemic; and the branchiæ are single on each side.

Gen. *Octopus* . . . . . *Spirula.*

### Second Order.

### TENTACULIFERA, *Giebel* (NEMATOPHORA, *Grant*).

The muscular arms surrounding the head support numerous filiform, sheathed tentacula, and are destitute of prehensile, cup-like suckers. The shell is always polythalmous, siphoniferous, external or internal. The heart is systemic, and the branchiæ are double on each side.

Gen. *Nautilus*.

## Seventh Class.

## PTEROPODA, *Cuvier*.

The pteropods, like most cephalopods, are aquatic, finned, natatory, cephalophorous mollusks, with internal pallial symmetrical branchiæ, and with the mantle cavity open anteriorly for the ciliary water-currents of respiration. The organs of locomotion are in form, not of feet, but of expanded, rayless, musculo-cutaneous, natatory fins, symmetrically developed on each side of the anterior end of the body. They are furnished with symmetrical cephalic tentacles, organs of hearing and of vision; but are destitute of prehensile cephalic feet and acetabula, and are furnished only with a rudiment of a muscular foot for prehension or creeping. The mantle cavity opens before or behind by an unsymmetrical ciliated orifice; the heart consists of two cavities; and both sexes are united in the same individual. They compose the two Suborders Gymnosomata (without exterior investing shell) and Thecosomata (furnished with a thin, exterior, calcareous, multiform shell).

## Eighth Class.

## GASTEROPODA.

The gasteropodous mollusks are furnished with a distinct head, supporting the organs of the senses, and containing the buccal cavity; and with a muscular foot adapted for creeping, extended under the ventral surface of the body.

The heart consists of two systemic cavities; and there are always distinct respiratory organs, mostly branchiæ, internal or external, sometimes pulmonary sacs for aërial respiration. The body is generally protected with an exterior, calcareous, conical, univalve, unilocular, and turbinated shell, closed with a horny or testaceous operculum. They are greatly varied in form, food, habitat, type, and grade of organization; most inhabit the ocean, some the fresh waters, and a few reside on land.

## First Order.

## PULMONATA, *Grant.*

Furnished with a distinct internal simple pulmonary sac, adapted for aërial respiration, and sometimes accompanied with external branchiæ for an aqueous habitat. They are phytophagous, and with both sexes on the same individuals. When the body is covered with an external calcareous shell, they form the Suborder Thecopneumata, and when destitute of shell, the Suborder Gymnopneumata.

## Second Order.

## THECOBRANCHIATA, *Grant.*

Furnished with distinct branchial organs for aquatic respiration, provided with an exterior calcareous shell more or less investing the body, and destitute of pulmonary sac for an aërial habitat. They are mostly marine, carnivorous, with the sexes on different individuals, and are divided into suborders chiefly by the forms of the investing shells.

In the *First Suborder* Buccinida, the margin of the aperture of the shell is furnished with a distinct groove, or prolonged canal, for the passage of a muscular ciliated infundibulum, to transmit water to the subpallial pectinated gills.

Gen. *Buccinum* . . . . . *Voluta.*

In the *Second Suborder* Turbinida, the shell is always turbinated, the margin of the aperture even and entire, without groove or canal for the transmission of a muscular

infundibulum or siphon. The branchiæ are always pectinated, placed under an open mantle, and with only a simple membranous fold to direct the respiratory currents.

Gen. *Paludina* . . . . . *Trochus.*

The *Third Suborder* Patellida is composed of tectibranchiated gasteropods, having the entire body covered with a simple conical shell, destitute of operculum, very rarely convoluted or turbinated, and with the margin of the aperture destitute of respiratory canal or groove.

Gen. *Dentalium* . . . . . *Sigaretus.*

The *Fourth Suborder* Carinarida consists of tectibranchiate gasteropods, having the body imperfectly protected with testaceous covering, from the shell existing only as an imperfect external or internal rudiment, and very rarely the branchiæ are protected only by a fold of the mantle.

Gen. *Sormetus* . . . . . *Phylliroe.*

## Third Order.

## GYMNOBRANCHIATA, *Grant.*

The nudibranchiate or gymnobranchiate gasteropods are always furnished with distinct free external gills for aquatic respiration, and never possess an exterior investing shell, nor pulmonary sacs. The musculo-cutaneous mantle, supporting variously formed branchiæ, sometimes contains an internal testaceous rudiment, and the muscular foot extends along the whole ventral surface of the body. These beautiful naked gasteropods are mostly phytophagous, marine hermaphrodites, and are conveniently arranged by the mode of distribution of the branchiæ.

In the *First Suborder* Tritonida, the numerous branchiæ on the naked surface of the body are disposed symmetrically on each side of the median plane.

Gen. *Tritonia* . . . . . *Glaucus.*

In the *Second Suborder* Polycerida, the branchiæ on the naked surface of the body are collected into a circle on the

median plane, and disposed around the posterior opening of the alimentary canal.

Gen. *Doris* . . . . . *Polycera.*

## Ninth Class.

## LAMELLIBRANCHIATA, *Blainv.*

(Syn. Conchifera, *Lam.* Lamellibranches, Acephalophores, Acephala testacea, Bivalvia, &c.)

Acephalous, aquatic, testaceous mollusks, invested with a mantle composed of two lobes; covered with a bivalve or multivalve calcareous shell; and provided with two pairs of pectinated, intrapallial, lamelliform, and symmetrical branchiæ. Mantle and branchiæ lined with vibratile cilia; no masticating or salivary organs; generally tentacular and auditory organs, and often pedunculated eyes. Mouth at the bottom of the pallial sac, heart with two systemic cavities sometimes subdivided; two pairs of ciliated labial appendages, to direct and seize the food; and with extensive water-vascular circulation through the body.

### First Order (*extinct*).

AMYARIA, *Grant.* (Syn. Rudista. Acardia. Fixivalvia, &c.)

*First Suborder.* Sphærulitida, *Grant.*

*Second Suborder.* Hippuritida, *Grant.*

### Second Order.

MONOMYARIA, *Lam.* (Syn. Pleuroconchæ.)

The monomyarian conchifers have the shell inequivalve, short longitudinally, extended transversely, rounded in form, with a single central muscular impression, sometimes partially divided, and with a restricted ligament and hinge. They are entirely marine, lie at the bottom on one side, have the body disposed horizontally, and the under valve

generally fixed to the surface on which they rest, and they greatly vary their characters in the same species. The mantle, being open around the margin, does not form a distinct and separate respiratory orifice and vent; the foot is sometimes present, oftener wanting, and the narrow ligament between the umboes is internal.

*First Suborder.* Apoda, *Grant.*

The muscular foot nearly or entirely wanting.
Gen. *Ostrea* . . . . . *Gryphæa.*

*Second Suborder.* Pododela, *Grant.*

With distinct muscular foot.
Gen. *Spondylus* . . . . . *Pecten.*

Third Order.

DIMYARIA, *Lam.* (Syn. Orthoconchæ, Plagimyona, &c.)

In the dimyarian lamellibranchiates the shell and body of the contained animal are extended in a longitudinal direction, and short transversely or vertically across the long axis. The valves are mostly equal and similar, are marked internally with at least two distinct muscular impressions, and between the two muscular impressions are extended a distinctly dentated hinge and a broad external ligament of attachment.

*First Suborder.* Chorisothecia. (Syn. Bifori- et Triforipalla, Asiphonidæ, &c.)

With the margins of the mantle mostly separate, and the muscular foot of considerable size.
Gen. *Arca* . . . . . *Tridacna.*

*Second Suborder.* Cliothecia, *Grant.* (Syn. Tubulipalla, [Siphonidæ, &c.)

With the edges of the mantle closely adhering, and

forming two exsertile tubes, and the muscular foot small or short.

Gen. *Cardium* . . . . . *Teredo.*

## Tenth Class.

## PALLIOBRANCHIATA, *Blainv.*

(Syn. Polymyaria, *Deshayes.* Brachiopoda, *Cuv.* Palliobranches, *Blainville,* &c.)

The brachiopodous bivalves are inequivalved, with the two parts of the shell placed, not, as usual, one on each side, but one above and the other below the body of the contained animal, and they are lined with the two lobes of the mantle. The valves are united together posteriorly, with or without a hinge, and are open anteriorly, their walls being perforated internally with numerous vertical tubuli lined with minute prolongations of the mantle. They are entirely marine mollusks, inhabiting the deeper parts of the sea, and are fixed in their habitat, either by a tubular pedunele passing through the lower valve, or directly by the shell; and the two lobes of the mantle are always free around their margins. Their parts are symmetrically disposed on each side of a longitudinal vertical plane bisecting the two valves, and they have a more complicated series of muscles connected with the valves, than are found in the other forms of conchifera. Two long convoluted, complicated, tentaculated, and ciliated labial appendages, often present, sometimes absent, directing as in other conchifera the ciliary currents or seizing food, can here be largely extended as arms from the interior of the shell, and have been thought to justify their being regarded as a distinct class of mollusca. Both auricle and ventricle appear to be divided in terebratula, as in arca. Mantle-lining, mantle-fringes, labial appendages, and their tentaculiform fringes, ciliated and respiratory.

First Order.

PEDUNCULATA, *Latr.*

Provided with a muscular tubular peduncle to attach the shell to marine substances.

Gen. *Lingula* . . . . . *Terebratula.*

Second Order.

SESSILIA, *Latr.*

Destitute of peduncle, and shell attached directly to marine substances.

Gen. *Crania* . . . . . *Orbicula.*

## Eleventh Class.

## HETEROBRANCHIATA, *Blainville.*

(Syn. Tunicata, *Lam.* Ascidies, *Sav.* Acephala nuda, *Cuv.* Heterobranches, *Blainville,* &c.)

Acephalous mollusks destitute of investing calcareous shell, destitute of muscular foot, breathing by simple reticulate diversiform branchiæ lining an internal respiratory sac, and covered with a continuous elastic tunic furnished with two apertures for the entrance and exit of the ciliary aqueous currents of respiration. Their blood is sometimes reddish. They are entirely marine, fixed or free, destitute of labial appendages, furnished with urinary organs, hermaphrodite, with two cavities of the heart, holoblastic, and undergo metamorphoses.

First Order.

STEREOSA, *Grant.* (Syn. Ascidiaria.)

With the body in the adult condition fixed to submarine substances.

*First Suborder.* Monastesia, *Grant* (Cynthioida).

With the body of each individual single, and isolated by its enveloping mantle.

Gen. *Cynthia* . . . . . *Bipapillaria.*

*Second Suborder.* Synadelphia, *Grant.* (Botryllia.)

With a compound body formed of different individuals organically united.

Gen. *Diazona* . . . . . *Botryllus.*

Second Order.

PLANETOSA, *Grant.* (Syn. SALPARIA.)

With the body unattached to foreign substances, and free for natatory progression.

*First Suborder.* Mononesia, *Grant.* (Biphoria.)

Body single, isolated, and free.

Gen. *Salpa* . . . . . *Monophorus.*

*Second Suborder.* Synnesia, *Grant.* (Syn. Pyrosomia.)

Body composed of several individuals organically united together, and forming a free natatory compound animal.

Gen. *Pyrosoma.*

## Third Subkingdom.

## ENTOMOID OR DIPLOGANGLIATED ANIMALS.

ENTOMOIDA, *Grant*; seu DIPLOGANGLIATA, *Grant.*

(Syn. ARTICULATA, *Cuv.* ARTHROPODA, *Gegenb.* INSECTA, *Linn.*)

The entomoid or diplogangliated classes have the trunk elongated, transversely segmented, provided with articulated members, and bilaterally symmetrical; and their moto-sensitive nervous axis is extended longitudinally

beneath the alimentary canal, furnished with numerous distinct symmetrical pairs of ganglia, and encompasses the œsophagus at its anterior extremity, developing there distinct supra-œsophageal or cerebral ganglia for the senso-voluntary organs and functions. The organs of sense and of motion are highly developed, and bilaterally symmetrical; the skeleton is external, investing, light, and deciduous; the masticating organs consist of articulated jaws, which move transversely; and the sexual organs are almost always double, bilaterally symmetrical, and placed on separate individuals, with internal impregnation and oviparous generation.

## Twelfth Class.

## CRUSTACEA, *Brisson.*

Aquatic entomoid animals, breathing by branchiæ, internal or external, with five or more pairs of articulated feet; with extensive circulation of the blood, aided by a dorsal vessel, or systemic muscular ventricle; mostly with compound eyes, two pairs of antennæ, solid calcareous shells, and several pairs of palpigerous jaws; and which undergo considerable metamorphoses at an early period of life.

### First Order.

### DECAPODA.

Head and trunk fixedly united by a continuous carapace; five pairs of ambulatory thoracic feet; eyes pedunculated and moveable; seven pairs of palpigerous jaws, and branchiæ concealed under an overarching carapace.

Gen. *Cancer* . . . . . *Astacus.*

### Second Order.

### STOMAPODA.

Carapace generally divided by a transverse moveable

suture; eyes pedunculated and moveable; branchiæ external, free, under the post-abdomen; cephalic pediform jaws greater than the ambulatory feet.

Gen. *Squilla* . . . . . *Phyllosoma.*

## Third Order.

## LÆMODIPODA.

Head and anterior segment of the trunk united together, and supporting the first pair of feet; eyes sessile; mandibles without palpi; four or more pairs of cystoid branchiæ, attached to the bases of the anterior pairs of feet; and furnished with external infra-thoracic marsupium for the expelled ova.

Gen. *Caprella* . . . . . *Cyamus.*

## Fourth Order.

## AMPHIPODA.

Eyes sessile; mandibles palpigerous; branchiæ cystoid, external, and post-abdominal; head always separate from the first pedigerous thoracic segment; thorax composed of seven pedigerous segments; heart a simple dorsal vessel; nervous columns and their ganglia separate from each other; infra-thoracic marsupium for the protection of the expelled ova; thoracic feet adapted for ambulatory, and caudal feet for saltatory and natatory progression.

Gen. *Talitrus* . . . . . *Gammarus.*

## Fifth Order.

## I S O P O D A.

Body depressed and broad, sometimes narrow and linear; eyes sessile, with seven pairs of similar, unguiculated, ambulatory thoracic feet, attached to seven moveable segments of the trunk; branchiæ sometimes laminæ, more rarely vesicles; ventral marsupium sometimes squamous, some-

times membranous; mandibles, when present, not palpigerous; heart a dorsal vessel; nervous columns contiguous, with small coalesced, equidistant ganglia.

Gen. *Limnoria* . . . . . *Porcellio.*

Sixth Order.

## BRANCHIOPODA.

Small entomostracous crustaceans, with an expanded carapace enveloping the whole body; with mandibles and maxillæ; monoculous or binoculous; with numerous external subabdominal membranous branchiæ, serving as feet for progressive motion.

Gen. *Cyclops, Cypris, Daphnia, Branchipus,* &c.

Seventh Order.

## EPICRIOPODA, *Grant.* (Antennipeda, *Grant.*) (Siphonostoma, *Latr., Gegenbaur,* &c.)

Head distinct, supporting a pair of antenniform organs of attachment; generally a pair of ocelli; mouth furnished with exsertile tubular sucker; a pair of maxillæ with palpi; body subcylindrical, slightly segmented, covered with soft elastic integuments, with biforate straight intestine; nervous columns generally separate; extensive circulation; sexes separate; trunk of the female terminated with two long narrow ovisacs; undergoing remarkable metamorphoses, being at first free, natatory, with cirrhigerous feet, and organs of vision; in the adult state fixed, suctorial parasites on the exterior of aquatic animals.

Gen. *Lernæa, Chondracanthus,* &c.

Eighth Order.

## PŒCILOPODA.

Mostly small, parasitic, suctorial, jawless, binoculous crustaceans, with two cephalic prehensile antennæ; mostly armed with proboscis for blood-sucking; with few segments

of the trunk; no post-abdomen; the trunk-segments are anisopodous, or pœcilopodous, from the feet being some prehensile, some natatory, some branchigerous, and some ambulatory. Most are siphonostomous, a few xyphosurous.

Gen. *Argulus* . . . . . *Limulus*.

## Ninth Order.

## TRILOBITA.

Carapace and segments trilobate; eyes pedunculated, or sessile, and immobile; feet small and enveloped by a broad carapace; body capable of being rolled up in the moveable segments of the trunk; mouth inferior, and provided with labium and labrum; undergoing great metamorphoses.

Gen. *Paradoxides* . . . . . *Cromus*.

## Tenth Order.

CIRRHIPEDA, *Lam.* (placed among Crustacea by Grant in 1830 (Lond. Univ. Cal. 1831. p. 90), and by Ehrenberg in 1836, and reinstated by Darwin, 1851.)

Head and trunk united; mouth furnished with palpigerous mandibles, and two pairs of dentated maxillæ; body subsegmented, covered with soft skin, supporting several pairs of symmetrical cirrhigerous feet, and enclosed in a fixed permanent, multivalve, calcareous shell lined with a secreting mantle; breathing by branchial laminæ, attached to the bases of the feet; undergoing early metamorphoses; sexes separate; entirely marine, and immoveably fixed in their adult condition; nervous columns separate; without eyes or antennæ; not parasitic.

### *First Suborder.* Pedunculata, *Lam.*

Body pedunculated, moveable, and enclosed in a compressed, calcareous or membranous shell.

Gen. *Pentalasmis, Pollicipes*, &c.

*Second Suborder.* Sessilia, *Lam.*

Body sessile, immoveable, enclosed in a conical calcareous operculated shell.

Gen. *Pyrgoma, Verruca,* &c.

Eleventh Order.

CILIOPODA, *Grant.* (Rotifera, Rotatoria, &c. placed among Crustacea by Leydig, Burmeister, &c.)

Head united to the trunk; furnished with ciliated organs of motion; one pair of dentated mandibles; and generally one or two sessile ocelli; trunk subarticulated, soft, elongated, rarely furnished with articulated appendages; body microscopic, transparent, mostly free, sometimes fixed by investing sheath or cell; with internal tubular branchiæ; with biforate alimentary canal, furnished with salivary and hepatic follicles; sexes separate; females often with exterior ovisacs; not parasitic; marine and freshwater; male smaller than female; often luminous; impregnate internally; great bilateral symmetry, extending to the internal parts.

*First Suborder.* Polytrocha, *Ehr.*

Ciliated rotatory organ divided into more than two parts.

Gen. *Hydatina,* &c.

*Second Suborder.* Zygotrocha, *Ehr.*

Ciliated rotatory organ divided into two parts.

Gen. *Rotifer,* &c.

*Third Suborder.* Schizotrocha, *Ehr.*

Ciliated rotatory organ with grooved or sinuous border, not divided.

Gen. *Megalotrocha,* &c.

*Fourth Suborder.* Holotrocha, *Ehr.*

Ciliated rotatory organ simple, continuous, with entire border.

Gen. *Ptygura,* &c.

## Thirteenth Class.

## ARACHNIDA.

Octopodal, apterous, terrestrial, entomoid animals, breathing by tracheæ or by pulmonary sacs, or by both forms of these organs, or sometimes by the surface of the body; not undergoing metamorphosis; spiracles 2–8, placed on the cephalothorax, or on the abdomen; no antennæ, nor compound eyes; one pair of maxillæ, supporting palpi often prehensile; eyes simple, sessile ocelli, not exceeding 12; mouth furnished with one pair of manducatory mandibular pincers; trunk divided into cephalo-thorax and abdomen, which are often united; circulation extensive; muscular partitions of the heart few; and symmetrical ganglia of the nervous columns concentrated; ova holoblastic; habits predaceous or parasitic.

### First Order.

### PULMONARIA, *Grant.* (Syn. Pulmonariæ, *Latr.*)

Breathing by pulmonary sacs alone; 1–8 spiracles, placed on the ventral surface; 6–12 ocelli; always maxillæ; sexual organs double and symmetrical in both sexes.

Gen. *Scorpio, Tarantula, Aranea.*

### Second Order.

### TRACHEO-PULMONATA, *Grant.*

Breathing both by tracheæ and by pulmonary sacs; anterior pair of spiracles opening into pulmonary sacs, and posterior pair into ramified tracheæ.

Gen. *Dysdera . . . . . Segestria.*

### Third Order.

### TRACHEATA, *Grant.* (Syn. Trachearіæ, *Latr.*)

Breathing solely by ramified tracheæ, forming isolated

tufts; one pair of spiracles opening on the lateral, or on the ventral surface; feet sometimes only six; small cephalo-thorax united with the abdomen into a rounded mass; mouth sometimes siphoniferous; sexual organs single.

Gen. *Galeodes, Phalangium, Trombidium.*

### Fourth Order.

APNEUMATA, *Grant.* (Syn. APOROBRANCHIA, *Latr.*)

Aquatic, marine, siphoniferous arachnidans, without perceptible spiracles, or distinct organs of respiration; body elongated, linear, composed of five segments; four ocelli on a dorsal tubercle; feet four pairs, with two additional ovigerous appendages in the females, closely connecting these minute suctorial arachnidans with læmodipod crustaceans.

Gen. *Nymphon, Phoxichilus, Pycnogonum.*

## Fourteenth Class.

## INSECTA.

Hexapodal, entomoid animals, with the body divided into head, thorax, and abdomen, with one pair of antennæ compound eyes, a muscular segmented dorsal vessel for circulation, extensively ramified tracheæ for respiration, mostly furnished with wings, undergoing distinct metamorphosis at a late period of life, and with the organs of generation double and symmetrical both in the male and female.

### First Subclass.

### ELYTROPTERA, *Latr.*

With elytra and membranous wings.

## First Order.

## COLEOPTERA, *Linn.*

Mandibulate insects, with the elytra entirely crustaceous and meeting with an even longitudinal suture; the membranous wings are longer than the elytra, and are folded up transversely beneath them; they have compound eyes, together with ocelli, and undergo complete metamorphosis.

1. Suborder. *Pentamera*, $\frac{3}{5}$
2. Suborder. *Heteromera*, $\frac{2-2}{5}$, $\frac{1-1}{4}$.
3. Suborder. *Tetramera*, $\frac{3}{4}$.
4. Suborder. *Trimera*, $\frac{3}{3}$.

## Second Order.

## DERMAPTERA, *Latr.*

With mandibles, compound eyes, elytra entirely crustaceous, and meeting with an even longitudinal suture, and short membranous wings, folded partly transversely, and partly longitudinally, like a fan; they undergo a demimetamorphosis, are always active, and have the trunk terminated with a pair of strong caudal forceps.

Gen. *Forficula.*

## Third Order.

## ORTHOPTERA, *Linn.*

Mandibulate, with coriaceous elytra, having an overlying suture and membranous wings, folded longitudinally; they undergo a demimetamorphosis, are always active, have compound eyes, and are furnished with caudal appendages.

### *First Suborder.* Cursoria, *Latr.*

With the hind legs formed for running or walking. Gen. *Blatta, Mantis, Phasma,* &c.

*Second Suborder.* Saltatoria, *Latr.*

With the hind legs formed for leaping. Gen. *Acrydium, Gryllus, Locusta.*

Fourth Order.

HEMIPTERA, *Linn.*

Haustellate, suctorial, without masticatory mandibles or maxillæ, with compound eyes, without palpi, with the elytra half coriaceous and half membranous, and with the inferior membranous wings short and folded longitudinally. They have mostly an incomplete metamorphosis, two or three simple ocelli, and one, two, or three articulations of the tarsi.

*First Suborder.* Heteroptera, *Latr.*

Beak terminal, body depressed and flat, and elytra membranous posteriorly. Gen. *Cimex.*

*Second Suborder.* Homoptera, *Latr.*

Beak inferior, body convex and thick, and entire elytra semicoriaceous. Gen. *Cicada, Aphis, Coccus,* &c.

Second Subclass.

GYMNOPTERA, *Latr.*

No elytra, four or two membranous wings.

Fifth Order.

NEUROPTERA, *Linn.*

With four nearly equal, naked, transparent, finely reticulate, membranous wings; mandibles and maxillæ for mastication; no haustellum nor caudal sting; with filiform antennæ, with compound eyes, and two or three simple ocelli, and undergoing metamorphoses of various kinds.

*First Suborder.* Subulicornes, *Latr.*

With subulate antennæ. Gen. *Libellula, Ephemera,* &c.

*Second Suborder.* Filicornes, *Latr.*

With long filiform antennæ. Gen. *Panorpa, Myrmeleon,* &c.

Sixth Order.

HYMENOPTERA, *Linn.*

With four membranous wings, veined with large meshes, extended horizontally, and of which the upper or anterior pair are larger than the posterior or inferior. They are mandibulate, furnished with an elongated tubular lower lip or labium, and the females are mostly provided with an ovipositor, or with a sting.

*First Suborder.* Terebrantia, *Latr.*

Abdomen of the female furnished with a saw or borer. Gen. *Tenthredo, Ichneumon,* &c.

*Second Suborder.* Aculeata, *Latr.*

Abdomen of the females and of the neuters furnished with a sting. Gen. *Formica, Mutilla,* &c.

Seventh Order.

LEPIDOPTERA, *Linn.*

With four membranous wings, covered with delicate, easily detached, farinaceous scales. They are haustellate, with compound eyes, and the mouth furnished with a spiral proboscis between the labial palpi.

*First Suborder.* Diurna. Gen. *Papilio.*

*Second Suborder.* Crepuscularia. Gen. *Sphinx.*

*Third Suborder.* Nocturna. Gen. *Phalæna.*

### Eighth Order.

### RHIPIPTERA, *Latr.* (STREPSIPTERA, *Kirby.*)

Mouth furnished with a pair of small styliform palpigerous mandibles; the anterior wings reduced to minute, coriaceous, clavate, elytriform balancers; the posterior wings large, naked, membranous, folded longitudinally like a fan, and traversed by distinct longitudinal fibrous rays. Gen. *Stylops* . . . . . *Xenos.*

### Ninth Order.

### DIPTERA, *Linn.*

With compound eyes, and often three simple ocelli; the labium in form of grooved proboseis, transmitting an armed suctorial tube, formed by the buccal organs; the anterior pair of wings straight, extended, naked and membranous; the posterior wings reduced to small, coriaceous, truncated halteres or balancers; undergoing complete metamorphosis, and mostly producing entirely apodal larvæ.

*First Suborder.* Ovolarvipara, *Grant.*

Producing ova or larvæ. Gen. *Culex, Tipula,* &c.

*Second Suborder.* Pupipara, *Grant.*

The young produeed when arrived at the pupa state. Gen. *Hippobosca, Nycteribia,* &c.

## Third Subclass.

## APTERA, *Linn.*

Hexapodal insects, without wings.

### Tenth Order.

### SIPHONAPTERA, *Latr.*

Mouth furnished with a sheathed sucker; body compressed, adapted for leaping; parasitic; sometimes small rudiments of wings; undergoing complete metamorphosis; larvæ apodal, and nymphæ inactive. Gen. *Pulex.*

### Eleventh Order.

### PARASITA, *Latr.*

No compound eyes; two or four simple ocelli; no rudiments of wings; body naked, depressed, destitute of caudal filaments, and of forked appendages; mouth often furnished with an exsertile sucker; tarsi terminated with strong prehensile forceps; no metamorphosis; always active.

Gen. *Pediculus, Ricinus.*

### Twelfth Order.

### THYSANOURA, *Latr.*

No rudiment of wings; mandibulate; ocelli in groups; always mandibles and maxillæ; body invested with scales or hairs; caudal filaments, or a forked tail, employed for leaping; no metamorphosis; always active.

Gen. *Lepisma* . . . . . *Podura.*

## Fifteenth Class.

## MYRIAPODA, *Leach.*

(Syn. Insecta myriapoda, *Latr.*)

Entomoid animals, with generally fifteen or more pairs of similar articulated feet; body elongated, numerously segmented, and without distinction of thorax and abdomen; head distinct, provided with one pair of antennæ, and two lateral groups of sessile ocelli; no compound eyes; the post-cephalic segments of the body freely moveable, equal, and furnished with one or two pairs of simple ambulatory feet; no wings; no metamorphosis. The mouth is furnished with mandibles and prehensile feet-jaws. They breathe air by ramified tracheæ opening by lateral stigmata, and never possess branchiæ. They are unisexual, terrestrial, predaceous; subsist chiefly on entomoid prey; moult their skin many times before maturity, and at each change acquire new additional segments and legs.

First Order.

CHILOPODA, *Latr.*

The labium formed by a pair of feet; mouth furnished with palpigerous mandibles, two palpiform appendages, and two strong unciform maxillæ, united at their base and pierced near their point. The integument flexible; body depressed; segments unequal; each segment with one pair of legs inserted laterally; antennæ sectaceous and multi-articulate; stigmata distinct; tracheæ anastomose longitudinally and transversely; the genital organs in both sexes situate posteriorly, and opening in the caudal segment, as in higher entomoids.

*First Suborder.* Inæquipedia, *Latr.*

Feet unequal and much elongated.
Gen. *Scutigera.*

*Second Suborder.* Æquipedia, *Latr.*

Feet nearly equal, and of moderate length.
Gen. *Lithobius* . . . . . *Scolopendra.*

Second Order.

CHILOGNATHA, *Latr.*

Labium formed by two mandibles; integument solid and calcareous; body long and cylindrical, or short and depressed; segments often united in pairs, and supporting two pairs of feet attached on the ventral side; antennæ 7-articulate; stigmata often indistinct; the genital organs in both sexes placed forwards in the trunk, and opening at the anterior and lower part of the body, as in many lower helminthoids.

*First Suborder.* Onisciformia, *Latr.*

Body oval-oblong, crustaceous, depressed, with conical appendices, the ventral aspect concave, capable of contracting into the form of a ball.
Gen. *Glomeris.*

*Second Suborder.* Anguiformia, *Latr.*

Body long, narrow, crustaceous, cylindrical, without conical appendices, and with or without ocelli.

Gen. *Iulus, Craspedosoma, Polydesmus.*

*Third Suborder.* Penicillata, *Latr.*

Body oblong, short, soft, depressed, ending posteriorly with pencil-shaped brushes, and composed of six segments, tufted each with lateral appendices.

Gen. *Polyxenus.*

## Fourth Subkingdom.

## HELMINTHOID OR DIPLONEUROSE ANIMALS.

### Helminthoidea, *Grant.*; seu Diploneura, *Grant.*

(Syn. Elminthoida, *Latr.* Vermes, *Linn.*)

Helminthoid, vermiform, or diploneurose animals have the body generally narrow, elongated, cylindrical, soft, subsegmented, destitute of articulated organs of motion, with the head little distinct from the trunk; the nervous cords simple, approximated or separate, extending longitudinally along the inferior aspect of the body; mostly inhabiting a moist or fluid medium, with means of transmitting water through their interior for respiration, or furnished with external branchiæ, and with great bilateral symmetry, both of their external and internal parts. The alimentary canal is generally straight, biforate, with terminal orifices; the masticating organs move transversely; the vascular circulation extensive; the habits mostly predaceous or parasitic, in accordance with their serpentine forms. Like entomoids, they consist mostly of a rectilineal repetition of similar simple parts, more or less intimately united, the segmentation being least in those nearest to the radiata, and most in those next to the entomoida.

## Sixteenth Class.

## ANNULATA.

(Syn. Annulida, Annulosa, Annelides, Annulati, &c.)

Body long, vermiform, articulated, with segments nearly equal, and moveable; the cephalic segments moveable, supporting generally separate sessile ocelli, antennæ, lateral maxillæ, and sometimes branchiæ; the trunk-segments generally with setæ or cirrhi, to assist in locomotion; body often invested with accessory or secreted tube, solid or flexible; often with dorsal branchiæ, external or internal, rarely with pulmonary sacs; often with internal, ramified, respiratory water-tubes; mostly with dorsal muscular vessel, red-coloured blood, arteries and veins for circulation; mostly hermaphrodites, requiring mutual impregnation, or self-impregnating.

### First Order.

### PNEUMOBRANCHIA, *Grant.*

With numerous simple respiratory sacs, opening externally by separate lateral stigmata, and equally adapted, and employed, for aërial or aquatic respiration.

Gen. *Lumbricus* . . . . . *Hirudo.*

### Second Order.

### NOTOBRANCHIA, *Latr.*

The dorsibranchiate, or notobranchiate annelides, breathe by external or internal branchiæ, symmetrically disposed along the dorsal aspect of the trunk.

Gen. *Aphroditâ* . . . . . *Pleione.*

### Third Order.

### CEPHALOBRANCHIA, *Latr.*

Mostly tubicolous, with antennæ, numerous ocelli, rudimentary cephalic cartilage; trunk-segments with single

setæ, or tufty cirrhi; filamentous cephalic tentacula; and head supporting ramified tufted branchiæ, into which red-coloured sanguineous fluid is injected from the branches of the dorsal artery.

Gen. *Serpula, Sabella, Terebella,* &c.

### Fourth Order.

### ENTEROBRANCHIA, *Latr.*

Simple, naked, aquatic annelides, without external branchiæ, or internal air-sacs, or cutaneous vibratile cilia; sometimes with prehensile buccal teeth, sometimes with terminal adhesive suckers; and breathing by ciliary water-currents, extensively conveyed through special internal canals, and also by the surface of the naked skin.

Gen. *Pontobdella, Climene, Nais, Stylaria,* &c.

## Seventeenth Class.

## SUCTORIA, *Goldf.*

(Syn. Entozoa, *Rud.*; Cotylides, *Van Beneden.*)

The suctorial, parasitic, intestinal worms are mostly soft, naked, simple, elongated, colourless or white; cylindrical or depressed, external or internal, helminthoid animals, destitute of solid skeleton, without distinct respiratory organs, almost without organs of sense or distinct articulations; breathing by their naked cutaneous surface; provided with sharp buccal spines for prehension or abrasion; having the mouth adapted for sucking fluid aliment; and residing permanently, or temporarily, within the bodies of other living animals.

### First Subclass.

### Nemathelmintha, *Gegenbaur.*

With long, narrow, vermiform, cylindrical or fusiform

body, with anterior terminal buccal orifice, mostly furnished with numerous spines, and without external cotyloid adhesive or suctorial disks.

### First Order.

### NEMATOIDEA, *Rudolphi.*

With long filiform body, tapered at both ends; with smooth, white, elastic, thick, transparent integument; mouth anterior, terminal, furnished sometimes with spines, sometimes with exsertile proboscis; alimentary canal with distinct terminal anal orifice; distinct unisexual genital organs, and impregnation internal; sometimes ocular points.

Gen. *Filaria* . . . . . *Liorhynchus.*

### Second Order.

### ACANTHOCEPHALA, *Rudolphi.*

Anterior part of the body covered with sharp spines, and capable of being retracted, and concealed within the buccal orifice; integument smooth and elastic; alimentary canal divided posteriorly, and without anal opening.

Gen. *Echinorhynchus.*

## Second Subclass.

## PLATYELMINTHA, *Gegenbaur.*

With broad, flat, depressed, soft body; sometimes short, simple, and single; sometimes long, aggregated, compound, and segmented; mostly furnished with numerous external cotyloid adhesive or suctorial disks.

### Third Order.

### TREMATODA, *Rudolphi.*

Body short, broad, depressed, with thin membranous

covering; a variable number of suctorial or adhesive disks, sometimes perforated in the centre; the mouth destitute of spines or proboscis; the alimentary cavity ramified, and destitute of anal opening; vessels for circulation; œsophageal nervous ganglia; organs of both sexes united in the same individual; impregnation internal; sometimes two unite by zygosis; and the embryos undergoing complicated metamorphoses.

Gen. *Monostoma, Distoma,* &c.

### Fourth Order.

### CESTOIDEA, *Rudolphi.*

Body elongated, depressed, flattened, soft, white, transparent, articulated, tape-like, terminated anteriorly with a rounded or depressed head, furnished with two or four suctorial orifices. The body is generally broadest in the middle, tapered to the cervix, and to the caudal end; and the head is sometimes provided with four simple or spinose antenniform lobes. They are mostly compound animals, attaining to a great length, where each segment of the body contains separately all the essential organs of nutrition and of generation. The segments have male and female organs united on the same individuals, as in the more isolated androgynous trematode worms. They are the adult forms of cystic entozoa, produced by the gemmation of successive segments from behind the head. Each segment is androgynous and oviparous. Cestoids produce only cysties from ova, and cystics produce only cestoids by gemmation, so that they alternate their generations.

Gen. *Caryophyllæus, Tænia,* &c.

## Eighteenth Class.

## TURBELLARIA, *Ehr.*

Minute, free, aquatic, naked-skinned, external, marine or fresh-water, abranchiated and apneumatous worms, with

the body sometimes eylindrieal, sometimes depressed, and for the most part more or less eovered externally with vibratile eilia, by whieh they swim, or ereep, and respire the surrounding element. The mouth is variously situated, generally near the middle of the ventral or of the dorsal aspeet of the body, simple, greatly dilatable, without masticating or salivating organs, and opening into a eapaeious eiliated stomach, whieh ramifies through the body without anal opening. Often furnished with numerous oeelli, and sometimes with auditory vestibule, eontaining a eretaceous lapillus. Habits predaeeous, subsisting chiefly on minute crustacea, or other lorieated aquatie animals, swallowed entire; and with the male and female organs plaeed sometimes on the same, and sometimes on different individuals.

First Order.

RHABDOCŒLA, *Ehr.*, *Schmarda.*

With the alimentary eavity of eylindrieal form.

*First Suborder.* Mierostomea, *Schmarda.*

Mouth minute, but greatly extensile. Gen. *Proporus, Disorus, Vorticeros,* &c.

*Second Suborder.* Pharyngea, *Schm.*

With protaetile, eonieal or eylindrical pharyngeal poueh. Gen. *Acmostomum, Vortex, Derostomum,* &c.

*Third Suborder.* Apharyngea, *Schm.*

No protraetile pharyngeal cavity. Gen. *Macrostomum, Telostomum, Convoluta,* &e.

*Fourth Suborder.* Rhynehoproboli, *Schm.*

With terminal extensile proboscis. Gen. *Prostomum, Rhynchoprobolus.*

*Fifth Suborder.* Aggregata, *Schm.*

The individuals assoeiated together in ehains, and with the head distinct from the body. Gen. *Catenula.*

Second Order.

DENDROCŒLA, *Ehr., Schm.*

With the alimentary cavity ramified.

*First Suborder.* Acarena, *Schm.*

No distinct head. Gen. *Dicelis, Tricelis, Tetracelis,* &c.

*Second Suborder.* Carenota, *Schm.*

Head distinct from the body. Gen. *Cephalolepta, Goniocarena, Carenoceræus,* &c.

Third Order.

NEMERTINEA, *Schm.*

Body elongated, depressed, narrow, tæniæform, with protractile proboscis, and mouth anterior or subterminal.

*First Suborder.* Abranchiata, *Schm.*

Without distinct respiratory cilia. Gen. *Borlasia, Polystemma, Rhamphogordius,* &c.

*Second Suoorder.* Rhochmobranchiata, *Schm.*

With fissiform respiratory openings. Gen. *Tubulanus, Tetrastemma, Ophiocephalus,* &c.

## Fifth Subkingdom.

## RADIATED OR CYCLONEUROSE ANIMALS.

Radiata, *Cuvier* (Cycloneura, *Grant*).

The radiated or cycloneurose animals have the parts of the body mostly radiated symmetrically from around a longitudinal vertical axis, with little tendency to bilateral symmetry, or to a rectilineal repetition of similar parts. The nervous axis is mostly in form of a simple circular cord disposed around the buccal entrance of the aliment-

ary cavity, often with the nerve-cells concentrated on one part of the ring. The body often plant-like, ramified, or dendritic, from the radiated repetition of similar simple structures. Acephalous, but mostly with tentacula around the mouth, and often ocelli, and auditory sacs with lapilli. They are aquatic animals, breathing by internal branchiæ, mostly marine, of simple internal structure, and complex exterior form; with rarely masticating organs; they are chiefly predaceous, swallowing their prey entire. The organs and forms of the sexes are nearly similar, often united on the same, sometimes placed on separate individuals; and the young undergo remarkable metamorphoses, being at first free, ciliated, natatory embryos, and often fixing by their base immoveably for after-life.

## Nineteenth Class.

## ECHINODERMATA, *Cuvier*.

Body distinctly cycloneurose and radiated; with testaceous or coriaceous covering, protected with external calcareous spines; solid parts composed of finely areolated texture, furnished with distinct biforate alimentary canal, presenting tentacula and ocelli around the buccal opening; with extensive circulation in arteries and veins, and extensive water canals for internal respiration, and to aid the functions of the closed tubular feet or pedicelli; the form radiated, ramified, globular, or elongated, with most of the organs, external and internal, disposed in quinary order around a longitudinal axis. They are slow, creeping, burrowing or fixed, marine animals, mostly predaceous, destitute of natatory organs, except in their ciliated embryo or larva state; monœcious, oviparous, holoblastic, mostly undergoing early, complete, and remarkable metamorphoses, and presenting considerable bilateral symmetry and helminthoid relations in their free natatory larva state.

First Order.

HOLOTHURIDA, *Grant.*

Body with elongated axis, free, soft, covered with coriaccous contraetile skin, naked, tuberculated, or spiculose; mostly with, sometimes without, ambulacra and tubular fect; alimentary canal biforate, with terminal orifices, and numerous peristomatous tentacula; branchiæ internal, tubular, and ramose.

Gen. *Sipunculus, Synapta, Holothuria,* &c.

Second Order.

ECHINIDA, *Grant.*

Body free, subglobular or depressed; covered with a complex articulated calcareous shell, solid and inflexible; with the mouth and anus distinct, the mouth furnished with simple or ramified tentacula, and often distinct oeelli; sometimes with teeth fixed in five circularly arranged maxillæ; the surfaee of the shell furnished with solid moveable spines, attached to fixed tubereles; five pairs of ambulacra for the transmission of pedicelli; convoluted intestine, attached by vascular mesentery; eirculation in arteries and veins; internal and external branchial respiration.

Gen. *Echinus, Cidaris, Spatangus,* &c.

Third Order.

ASTERIDA, *Grant.*

Body free, radiated, depressed, always without peduncle, covered with coriaceous contractile skin, armed with sessile tubercles or spines, and triarmate pedicellariæ; mouth central, inferior, furnished with tentacula, and opening into a central stomach, sometimes furnished with a separate minute anal eanal; circulation in arteries and veins; internal and external branehiæ; ocelli, when present, at the lower surface of the ends of the rays.

Gen. *Asteracanthion, Stichaster, Echinaster,* &c.

### Fourth Order.

### CRINOIDA, *Grant.*

Body radiated, provided with a jointed pedunele, mostly permanent, very rarely deciduous; mouth and anus distinet; trunk invested with symmetrieal ealcareous plates, furnished with jointed tentaculiform arms, extended always from the dorsal side of the abdominal cavity; alimentary canal extended from the central stomach through the jointed stem; extensive eirculation in distinet vessels; genital organs on different individuals, confined to the abdomen, numerously divided, and symmetrieal.

Gen. *Comatula, Encrinus, Pentacrinus,* &e.

## Twentieth Class.

## ACALEPHA.

(Syn. Medusa, *Linn.* Arachnoderma, *Blainville.*)

Radiated, free, soft, natatory, marine animals, with naked skin, and colourless transparent internal texture; with the parts of the body mostly disposed in quaternary order around a longitudinal axis, without distinet abdominal eavity, and with the exterior surfaee of the body largely furnished with minute filamentous stinging organs of defence. With one or many bueeal openings, leading to a distinet, but not free or membranous eentral stomaeh, from which radiate ciliated nutritive eanals ramifying through the substance of the body. Nervous axis eireular, with often cerebral sensitive ganglia giving sensitive nerves to distinct oeelli, to vestibular saes with cretaeeous lapilli, and to numerous tentacula. Internal, ciliated, respiratory water-eanals. Swimming slowly by the rithmic action of a muscular discoid mantle, or aided by air-saes, or by marginal eirrhi, or by large external vibratile cilia. Generally possessing bright luminosity. Predaeeous, feeding chiefly on minute crustacea. Gregarious, colouring by day, and illuminating

by night, great tracts of the ocean. The luminosity produced by the oxydation or combustion of their carbon. They are mostly single, sometimes composite, zoophytoid animals. Distinct male and female sexual organs are generally united on the same individuals; ova holoblastic; embryo ciliated; and the young undergo remarkable metamorphoses, extending through successive generations.

### First Order.

### PALLIOGRADA, *Grant.*

(PULMOGRADA, *Blainv.* DISCOPHORÆ, *Eschscholtz.*)

Body in form of a round convex disk above, containing the principal nutritive organs excavated in its tissue; concave below, with the mouth generally single and central; sometimes with numerous peripheral openings; supporting, around the margin of the mantle, numerous long filiform tentacula, sessile or pedunculated ocelli, and sometimes vestibular auditory sacs containing cretaceous lapilli. Destitute of solid parts, external or internal, they swim by the contractions of the muscular peripheral parts of the discoid mantle.

Gen. *Rhizostoma, Medusa, Geryonia, Oceania, Æquoria, Berenice,* &c.

### Second Order.

### PHYSOGRADA, *Grant* (SIPHONIFERÆ, *Eschscholtz*).

Body composite, zoophytoid, free, natatory, symmetrical, elongated; suspended vertically by air-sacs, by the relaxation or compression of which they regulate their height or depth in the sea; provided with a prominent, conical, tubular, suctorial, or prehensile mouth; furnished with numerous small perforated suctorial tubes for respiration or nutrition; with long filiform tentacula, and variously formed ovigerous and natatory appendages.

Gen. *Physalia, Rhizophysa, Diphya,* &c.

### Third Order.

### CIRRHOGRADA, *Blain.*

Body free, natatory, furnished with a thin, light, laminated, cartilaginous or partially calcified, internal skeleton, having interseptal spaces often containing air, and protecting the nutritive and generative organs beneath. The mouth is muscular, conical, proboscidiform and central below, surrounded with small tubular gemmiferous organs, like polypi, for prehension or respiration. The body is invested with musculo-cutaneous coloured mantle, the inferior peripheral margin of which extends into tentaculiform cirrhi for locomotion.

Gen. *Rataria, Velella, Porpita.*

### Fourth Order.

### CILIOGRADA, *Blainville* (Ctenophora, *Eschscholtz*).

Body diversiform, soft, transparent, colourless, natatory, furnished with external bands of large vibratile cilia serving for locomotion. No air-sacs, nor muscular discoid mantle, nor marginal cirrhi to assist in progression; with capacious excavated gastric cavity, wide ciliated water-canals, tubular filiform tentacula projected by internal water-currents, bright luminosity, nervous ganglia, auditory sacs with lapilli, and numerous male and female organs united on the same individual.

Gen. *Mnemia, Beroe, Callianira,* &c.

## Twenty-first Class.

## POLYPIFERA, *Grant.*

(Polypi *auctorum.*)

Simple or compound, aquatic, radiated animals, of a plant-like form, mostly fixed, sometimes free, generally protected with a calcareous or horny, external or internal

skeleton, and furnished with distinct, sensitive, prehensile and digestive polypodal sacs, developed from the periphery of their soft fleshy body.

## First Subclass.

### Bryozoa, *Ehrenberg* (Polyzoa, *Thomson.* Podobranchia, *Grant*).

Fixed or free, compound, aquatic, loricated or sheathed zoophytes, with free, ciliated, hollow, branchiform tentacula disposed more or less around the mouth, and furnished with distinct biforate alimentary canal. With distinct gastric sac, hepatic follicles, sometimes pharyngeal teeth, œsophageal ganglia, and both male and female organs on the same individuals. Having some affinities to acephalous mollusks in their ciliated tentacula, and their separate anal opening; but without biforate sac for respiration, or heart for circulation, or cloacal sac for the alimentary and genital openings, or non-tubular sensitive fleshy tentacula.

### First Order.

### LITHOCYSTICA, *Grant.*

With solid inflexible calcareous cells protecting the polypi and composing the polyparium.

Gen. *Eschara, Cellepora, Retepora,* &c.

### Second Order.

### KERATOCYSTICA, *Grant.*

With horny or membranous, flexible cells investing the polypi, and composing the polyparium.

Gen. *Flustra, Bowerbankia, Alcyonella,* &c.

## Second Subclass.

### Anthozoa, *Ehrenberg.*

Fixed or free, radiated, compound or simple, aquatic,

mostly polyparian zoophytes, furnished with sensitive, prehensive, peristomatous, contractile tentacula; with distinct, free, membranous parietes of the alimentary canal, and separated from the skin of the polypus by vertical septa; destitute of separate external anal opening of the polypi; and with distinct organs of both sexes united on the same individuals.

### Third Order.

### POLYACTINIA, *Ehrenberg.*

Radiated, polypiferous, anthozoic zoophytes, with twelve or more tentacula around the mouth of the polypi, and arranged concentrically.

Gen. *Actinia, Zoanthus, Fungia, Oculina, Madrepora,* &c.

### Fourth Order.

### OCTACTINIA, *Ehrenberg.*

Anthozoic, polypiferous, radiated zoophytes, with eight broad fringed tentacula disposed in a single row around the mouth of the polypi; always compound, and furnished with polyparium.

Gen. *Xenia, Tubipora, Halcyonium, Veritillum, Pennatula,* &c.

## Third Subclass.

## HYDROIDEA, *Grant.*

(Hydrina, *Ehrenberg.* Hydriformia, *V. der Hoeven.* Polypi vaginati, *Lamarck.*)

Fixed or free, simple or compound, radiated, hydraform zoophytes, with a simple, sarcodous, contractile, granular flesh, forming the tissue of the body; without distinct membranous stomach separate from the cutaneous wall of the polype; with a variable number of highly prehensile tubular tentacula around the mouth; without separate anal opening of the polypi; with extensive internal ciliated

canals extending from the gastric cavity into the tentacula; mostly furnished with external, investing, tubular, ramified, horny, flexible, or membranous sheath; both gemmiparous and oviparous, without permanent distinct generative sexual organs; and the products of the periodically evolved ova undergoing remarkable metamorphoses.

### Fifth Order.

### VAGINATA, *Lamarck.*

Simple or compound, tubular, internally ciliated, sarcodous body, invested with a fixed, permanent, flexible sheath; with persistent open cells for the protection of the polypi, and deciduous closed vesicles for the development of the generative products.

Gen. *Tubularia, Campanularia, Sertularia,* &c.

### Sixth Order.

### GYMNOSARCA, *Grant* (Hydrina, *Ehrenberg*).

Simple or compound, free or fixed, tubular, sarcodous, hydraform zoophytes, with hollow, internally ciliated, prehensive, sensitive tentacula, and with the soft homogeneous fleshy body destitute of external investing horny sheath.

Gen. *Coryna, Hydractinia, Hydra,* &c.

## Sixth Subkingdom.

## PROTOZOIC OR ACRITONEUROSE ANIMALS.

### Protozoa, *Siebold* (Acritoneura, *Grant*).

The protozoic or acritoneurose animals are mostly unsymmetrical, amorphous or polymorphous, composed of a simple, soft, homogeneous, cellular sarcode, or fleshy substance possessing contractility and apparent sensibility; without distinct membranous structures, lining internal cavities; without distinct muscular or nervous fibres; some-

times with internal nutritive eavities, merely excavated in the sarcodous mass of the body; without glandular or other speeial internal organs; and sometimes without any internal eavity or buceal opening. The motions of the sarcode are slow and continuous, but the locomotion of the body, and the motions of nutriment internally, are mostly effeeted by vibratile eilia in the higher forms of these animals. In the lower forms, the movements are chiefly effected by temporary extensions of parts of the general sarcode, termed pseudopodia, and the whole sarcode appears to be an aggregate of nuelei or imperfect cells conneeted together by a more fluid nutritive and formative homogeneous blastema.

They are mostly predaceous, and inhabitants of a fluid or moist medium. They manifest great mutations in their development and metamorphoses, and great diversities in their modes of origin and their means of generation; often passing through an extended series of most dissimilar forms in their transition from lower to higher grades; sometimes their formative nuclei originate in the lowest forms, by the union of their fluid organic elements, without the aid of vitality (unless derived from the forees evolved by the decomposition of eompound fluid organie elements, and their passage to the simpler binary eondition of mineral eompounds). Many of the acritoneura are entirely destitute of solid parts, external or internal; some are furnished with investing horny or dermal sheaths, or internal horny fibres often strengthened with silicious or ealeareous spieula; many are proteeted with exterior calcareous eells, and some are invested with monothalamous, symmetrical, silicious loricæ. Fissiparous, gemmiparous, and oviparous modes of generation, varied with the phenomena of encystation, and zygosis or eonjugation, are eommon in the protozoic or sareodous elasses, but without the presenee of any form of permanent generative organs male or female.

## Twenty-second Class.

## EPITRICHA, *Ehr.*, *Van der Hoeven*, &c.

(Syn. Ciliata, *Perty, Claparède*, &c. Infusoria (partim), *Müller*, &c.)

Minute, microscopic, soft, transparent, aquatic, simple, sarcodous animalcules, with a distinct internal digestive cavity, provided with a permanent buccal orifice and a separate anal opening; destitute of internal membranous organs, or organized membranes, and of muscular and nervous fibres, and of external pseudopodia; furnished with one or more internal nuclei connected with generation; with one or more distinct internal subcutaneous pulsating bodies or sacs, which have sometimes short canals extending from them, and the two halves of which continue to pulsate separately when one is artificially divided; they generally manifest a cyclosis, continuous or interrupted, of the semifluid contents of their digestive cavity; they often present traces of bilateral symmetry in the form of the body, and in the position of the two openings of their alimentary cavity; and they are always furnished with external cutaneous vibratile cilia as their organs of locomotion. The distinct contractility of their sarcodous body, and their apparent sensibility to visual, gustatory, and tactile impressions, render it probable that they have muscle-matter and nerve-cell-matter in their homogeneous tissue, though not in fibrous form. In encystation the nuclei and the sarcode break up into numerous embryo-forming parts. They are fissiparous and gemmiparous, fresh-water and marine, and are allied both to the sarcodous hydroid zoophytes, and to the ciliated turbellarian worms.

### First Order.

### PERITRICHA, *Stein.*

With the vibratile cilia disposed around the anterior end of the body.

Gen. *Vorticella*, &c.

Second Order.

HYPOTRICHA, *Stein.*

With the vibratile cilia nearly or entirely confined to the under surface of the body; with traces of bilateral symmetry; dorsal surface convex, inferior surface flat, and with the mouth and anus subterminal on the ventral aspect, never terminal.

Gen. *Onychodromus,* &c.

Third Order.

HETEROTRICHA, *Stein.*

With the vibratile cilia placed irregularly on the body.

Fourth Order.

HOLOTRICHA, *Stein.*

With the vibratile cilia disposed over the whole surface of the body.

Gen. *Paramæcium,* &c.

Fifth Order.

FLAGELLIFERA, *Grant* (Flagellata, *Stein*).

With a single terminal filiform or flabelliform vibratile cilium for locomotion.

Gen. *Euglena,* &c.

## Twenty-third Class.

## PORIFERA, *Grant.*

(Syn. Polytrita, *Homer, Il. & Odyss.*)

Soft, sarcodous, fixed, aquatic, polymorphous, or amorphous animals, nearly apathic or very inert, always destitute of fibrous or membranous skin; with the surface variously perforated with minute contractile ciliated pores, left be-

tween the constituent sarcode-cells, for the entrance of water-currents for nutrition and respiration; having the body largely traversed internally with partially ciliated canals, which commence from the surface-pores, ramify or anastomose through the tissue of the entire animal, and collect to form larger vents opening on convenient parts of the surface for the exit of the currents.

The soft fleshy mass of the body, composed of independent nucleated cells, is supported with an internal fibrous, horny, or chitinous skeleton, which is most generally strengthened with imbedded silicious or calcareous, hollow or solid spicula. The exterior is sometimes condensed into a more continuous pellicle, by the mere agglutination of the ordinary surface-cells of the sarcode; the sarcodous covering sometimes forms numerous small superficial pits, or rudimentary polype cavities, in which the absorbent pores are then placed. Both the pores and vents are capable of slow contraction and dilatation, but no muscular or nervous fibre or membrane exists in the sarcodous mass, nor permanent organs of generation or other function. The constituent amœbaform cells are seen to seize, surround, and digest animalcule prey. The superficial spicula of the adult are generally much smaller than the deeper seated, are contained each in its formative cell, and are seen also on the surface of the gemmule. The spicula, at first hollow and flexible, enlarge and consolidate by addition of laminæ, and from simple become highly complicated and often highly symmetrical. The isolated cells of the sarcode have no pulsating body or sac as epitricha, and pass slowly through changes of form, like an amœba, being individually contractile as well as collectively. The cells supporting vibratile cilia when isolated resemble flagelliferous epitricha, their vibratile filament, or sometimes two, originating from a spherical cell.

At determinate seasons they originate and detach ciliated reproductive free gemmules, which attach themselves to hard substances and grow to the form of the parent. They also periodically develope male and female cells,

which produce each respectively numerous spermatozoa or ova—the spermatozoa developed as usual in small internal cells, and the ova with macula germinativa, germinal vesicle, and vitellus. Separate individuals of the same species easily unite into one; and sometimes the entire adult is spontaneously fissiparous. Some cells are green with chlorophyl, some stretch across a pore and divide it, and the pores of spongilla have been seen to remain forty hours open and active. Some are seen to close up vents with sarcode, and open new vents near them. Around the pores are found concentric rings of ciliated cells, some monad-like with one vibratile cilium, others with two cilia; sometimes the whole pores entirely close up temporarily, giving the surface the appearance of a continuous cutis; sometimes they entirely reopen, and render the whole surface reticulate. The pores have no tentacular protection, nor any power of selection of the particles which can enter; but entering animalcules are soon surrounded with sarcode-cells in the superficial depressions, and digested by their contact, as in the body of a rhizopod; and the pulsating sac of the victim has been seen contracting for half an hour after being seized by the sarcode-cells. The developing nucleated gemmules are at first coarsely cellular and without cilia, then acquire ciliated epithelium for their distribution in the waters when set free.

### First Order.

### KERATOSA, *Grant.*

With a *horny* fibrous axis; few or no spicula, calcareous or silicious; entirely marine; generally large, soft, elastic, brown-coloured, and mostly inhabitants of the warmer parts of the ocean. The horny fibres are sometimes coarse, tubular, and friable; sometimes fine, tubular or solid, and highly elastic; sometimes solid and brittle, with entirely imbedded or partially imbedded spicula.

Gen. *Spongia.*

### Second Order.

### LEUCONIDA, *Grant.*

With white, *calcareous,* fibrous axis, chiefly composed of hard, brittle, simple and compound, large and small, hollow spicula composed of carbonate of lime; body sometimes sessile, sometimes tubular or hollow, mostly small, with little chitinous matter uniting the spicula; friable, non-elastic, entirely marine, and inhabiting chiefly cold or temperate seas.

Gen. *Leuconia, Leucalia, Strangia, Vioa.*

### Third Order.

### CHALINIDA, *Grant.*

With fibrous axis chiefly composed of *silicious* spicula, connected together with chitinous elastic matter; the spicula, simple or compound, dense, hollow, brittle, transparent, colourless, large in the deeper parts, minute on the superficies and on the gemmules; body polymorphous, generally sessile, branched, or tubular; colours mostly brown, grey, red, or green, and inhabiting the seas and the fresh waters chiefly of temperate latitudes in both hemispheres.

Gen. *Chalina, Spongilla, Tethya.*

## Twenty-fourth Class.

## FORAMINIFERA, *D'Orbigny.*

(Syn. Polythalamia, *Ehr.*)

Minute, simple or compound, free, sarcodous, marine, testaceous animals, covered with a calcareous or silicious, polythalamous or monothalamous, thin and light shell, the surface of which is mostly furnished with numerous minute foramina, allowing the transmission through them of pseudopodia, or fine filiform coalescible extensions of the common flesh of the enclosed body, and in which moving granules are seen. The homogeneous sarcode filling the inte-

rior of all the united foraminated cells is sometimes spicular both in monothalamia and polythalamia, as in porifera; but it presents no distinct fibre or membrane, or permanent internal organ for any function, nor even a pulsating vesicle, and appears equally nourishable at every point. An internal nucleus is very rarely perceptible. A symmetrical series of investing cells are often periodically secreted or gemmated around the periphery of the body, and very long coalescible pseudopodia are continually being extended through their surface-apertures for reptation, prehension, or gemmation. The cells intercommunicate by perforations of their septa, by which they gemmate new cells, or peripheral series of cells, during their growth. The same species present the greatest diversities of form. They are abundant inhabitants of deep seas, sometimes floating by aid of a fat-globule, predaceous and parasitic, found on zoophytes and other radiata, and their debris form vast accumulations of loose sands, calcareous or silicious, in the present ocean as in all past eras from the silurian epoch. They are divided nearly thus by D'Orbigny.

## First Subclass.

### Polythalamia, *Claparède.*

Body composed of several segments, and shell consisting of several distinct cells variously united.

### First Order.

### CYCLOSTEGA, *D'Orbigny.*

Body-segments arranged circularly, and shell discoid, composed of concentric cells, simple or compound, and without spire.

Gen. *Cyclolina, Orbitolites, Orbitolina, Orbitoides.*

Second Order.

STICHOSTEGA, *D'Orb.*

Body composed of segments placed in a single line, and shell formed of a series of cells superimposed on each other, end to end, on a single axis, straight or arched, and destitute of spiral.

Gen. *Glandulina, Nodosaria, Orthocerina, Dentalina, Frondicularia, Lingulina, Vaginulina,* &c.

Third Order.

HELICOSTEGA, *D'Orb.*

Body-segments rolled upon each other in a spire, and chambers of the shell superimposed on each other on a single axis, forming a convoluted spire.

Gen. *Cristellaria, Flabellina, Robulina, Fusulina, Nummulites, Assilina, Siderolina,* &c.

Fourth Order.

ENTOMOSTEGA, *D'Orb.*

Body composed of alternating segments forming a spire. The shell formed of chambers superimposed on two axes alternating with each other, and rolled together in a spiral form. The shell is of a vitreous texture though calcareous, and is rarely perforated with superficial foramina.

Gen. *Asterigerina, Amphistegina, Heterostegina,* &c.

Fifth Order.

ENALLOSTEGA, *D'Orb.*

Body-segments applied to each other alternately, without forming a spire. Shell composed of chambers joined together alternately on two or three distinct axes, without forming a spire.

Gen. *Dimorphina, Guttulina, Globulina, Polymorphina, Cuneolina, Textularia,* &c.

### Sixth Order.

### AGATHISTEGA, *D'Orb.*

Segments of the body coiled upon each other around a single axis. Shell formed of chambers superimposed on each other around a common axis, each cell occupying half the circumference. The texture of the shell is compact and smooth, without pores.

Gen. *Biloculina, Fabularia, Spiroloculina, Triloculina, Articulina, Sphœroidina, Quinqueloculina, Adelosina,* &c.

## Second Subclass.

### Monothalamia, *Claparède.*

Body undivided, and shell consisting of a single cell, silicious or calcareous.

### Seventh Order.

### CHALICOSTEGA, *Grant* (Polycystina, *Ehr.*; Radiolaria, *Müller*).

Shell *silicious,* symmetrical, minute, radiated, foraminated, most diversiform, composing a single, sometimes a multiple chamber; body simple, sarcodous, undivided, sometimes containing a fat-globule with spicula, sending out pseudopodia through the foramina or tubes of the shell, and sometimes only partially filling its cavity; no nuclei; no pulsating vesicle.

Gen. *Podocyrtis, Cephalolithis, Haliomma, Rhabdolithus, Perichlamydium, Rhopalocanium, Lychnocanium, Lithocampa, Encyrtidium, Flustrella, Dictyospyris, Stephanolithis, Acanthometra,* &c.

### Eighth Order.

### MONOSTEGA, *D'Orb.*

Shell *calcareous,* solid, composed of a single cell, foraminated on the surface, and containing a soft sarcodous body

consisting of one undivided mass, transmitting long coalescible pseudopodia.

Gen. *Goniolina, Conodictyum, Dactylopora, Ovulites, Oolina, Orbulina,* &c.

## Twenty-fifth Class.

## RHIZOPODA, *Dujardin.*

Minute, free or fixed, simple, sarcodous, fresh-water or marine animalcules, destitute of calcareous or silicious shell, without vibratile cilia, and furnished with greatly extensile, prehensive, sometimes suctorial pseudopodia; body entirely naked, or covered only with a soft or coriaceous integument. They are mostly predaceous, entangling their victim with the numerous coalescing pseudopodia, and immersing it entire in the soft sarcodous substance of their body. The pseudopodia in some, as the Gromiæ, readily and entirely coalesce on coming into contact with each other; in others, as in Amœbæ, Arcellæ, Difflugiæ, and Acinetæ, they mostly remain isolated, even though coming into mutual contact. Several naked rhizopods present both internal nuclei and pulsating vesicles, like the higher epitrichous animalcules. The highest condition of the pseudopodia is seen in the Acinetæ where they are tubular and suctorial organs. In the long, slender, and highly coalescible pseudopodia of Actinophrys, as in those of Foraminifera, internal moving granules are seen in their tissue. The non-coalescible pseudopodia are mostly short, thick, and well defined, as in Difflugia and Amœba.

### First Order.

### GROMIDA, *Claparède.*

Body covered with a soft, flexible, coriaceous tunic perforated with numerous foramina, through which long filamentous and highly coalescible pseudopodia are constantly being extended and retracted.

Gen. *Gromia, Lieberkuehnia,* &c.

### Second Order.

ACINETIA, *Grant* (Infusoria suctoria, *Claparède*).

Body sarcodous, free or fixed by peduncle, and furnished with tubular, suctorial, retractile pscudopodia; body always free and ciliated in the embryo state.

Gen. *Acineta, Podophrya,* &c.

### Third Order.

PROTEINA, *Claparède.*

Body sarcodous, entirely destitute of calcareous, silicious, or coriaceous investing tunic, and furnished with pseudopodia without tubular interior, rarely coalescing, of various forms, and variously endowed.

Gen. *Actinophrys, Difflugia, Arcella, Amœba,* &c.

## Twenty-sixth Class.

## CYSTODIA, *Grant.*

(Infusoria simplicissima, *Van der Hoeven.*)

Body cystoid, microscopic, simple or compound, always destitute of distinct buccal opening; consisting of simple granular nucleus, or simple cell, nucleated or nucleolated, or cells partially or entirely divided, and always destitute of organized fibre, membrane, or internal permanent organ for any function; mostly spherical or elongated, simple or aggregated cysts, always inhabiting a fluid or moist medium, and sometimes furnished with very minute pores extending through the cell-wall. Sometimes developing external vibratile cilia, readily multiplying by fissiparous generation, always endowed with distinct independent vitality, and mostly undergoing remarkable metamorphoses when arrived at maturity. Always distinctly originating *de novo* from their fluid organic elements, free in the exterior fluids of the globe, or in those of living or dead organized bodies (monadinea and endocystica). Their formation

mostly preceded in endocystics by a plastic homogeneous, gelatinous or albuminous, formative plasma or protoplasm, and the cell-wall consists merely of this condensed protoplasm, and never of organized membrane, nor is furnished with a distinct cellulose lining as seen in the vegetable cell.

Always effecting their own nutrition, growth, changes, metamorphoses, and reproduction, by their own vital endowments, and their fissiparous generation, complete or incomplete, accompanied by a fissuring of the nuclei and the cell-contents, as in higher acritoneura. Capable of coalescing structurally and functionally, more or less, in all their conditions from the first plasmic nuclei, and constituting various kinds of sarcode and higher tissues, where their living phenomena appear often to combine harmoniously to one end. The study of their normal properties and phenomena is of fundamental importance in physiology, and that of their abnormal, opens a new era in pathology. Schwann, Kölliker, Leydig, and other eminent microscopical inquirers, have compared the union of the organic molecules to form the nuclei to a kind of chemical precipitation or slow organic crystallization; but, perhaps, the general intervention of the plastic plasmic condition, which precedes the appearance of the separate moving particles, may entitle the phenomena of "nuclification" to rank in a separate class from the former.

## First Order.

## GREGARINEA, *Lieberkuhn.*

Simple, sarcodous, astomatous, round or elongated, depressed, nucleated or nucleolated, parasitic, extremely inert cells, effecting complete zygosis and encystation before reproduction, found in the alimentary canal and other organs of annelides and many higher animals, sometimes developing anterior uniciform processes, and not receiving the coloured particles of infusions into their interior. The recent researches of Bary of Prague on some forms of Mycetozoa, which develope as parasites on organized matter, never

possess chlorophyl, nor nucleus, nor pulsating sac, nor external vibratile cilia, nor mouth, nor internal cyclosis, nor cell-wall pores, show them to be closely allied to the Gregarinea, perhaps referable to the same order. They are composed of aggregations of simple cells, commonly referred to the vegetable kingdom; the cells elongate to form filaments, some dividing or branching, and they subsist on organic matter, not on mineral matter like plants. These forms of fungi are highly nitrogenous and nutritive like other animal substances, often poisonous, often destructive parasites on man and on all other forms of organized bodies, animal or vegetable, living or dead. But as the limits of the three kingdoms of matter are not fixed either conventionally or by nature, there will always be organisms as well as mineral substances resting on disputable ground.

Gen. *Gregarina*, &c.

## Second Order.

## ENDOCYSTICA, *Grant.*

Body in form of simple granular nuclei, or single-walled cells, simple, nucleated or nucleolated, found in the tissues and fluids of living animals, astomatous or sometimes furnished with cell-wall pores, originating from their fluid elements, commonly passing through a prenuclear plastic homogeneous semifluid condition of formative protoplasm, always distinctly endowed with independent vitality, and effecting their own nutrition, growth, development, metamorphoses, and generation. Never originating *ab ovo*, nor in the exterior fluids of the globe, nor from any changes of form effected on monadinea, or on protophytic cells, taken into the living body as food. They readily enlarge, consume their nutritive blastema, develope cilia, form fluids or solids in their interior, multiply by fissiparous generation like the ectomonads of the waters, as seen in every soft tissue, and in the dividing blood-corpuscles of the young of mammalians and birds. They compose a large portion of the normal and abnormal living fluids of ani-

mals, as chyle, blood, milk, lymph, and of the secretions and excretions. By their multiplication and metamorphoses, they originate the soft tissues, as connective, muscular, nervous, capillary, and cartilaginous, both healthy and morbid, and also the harder epidermic and osseous tissues, and all the soft and solid textures throughout the animal kingdom. They cover the surface, line the cavities, and form continuous membranous strata of living animals, as the epidermic layer, the epithelial, the pigmentary, and others. They are seen in all their stages, from their formative plasma, in the tubuli of glands, whose secretions they elaborate in their sarcodous abdominal cavity, by their own special vital endowments, or vital forces. "Like most internal organized tissues, the exterior epidermic covering originates from minute cells, or *cytoblasts*, which possess, like entozoa, an independent means of growth, and undergo various changes in the course of their development." .... "The black pigment-cells of the cuticle of the tadpole undergo remarkable changes of form, like a polygastric proteus, and they contain numerous, minute, parasitic, spontaneously moving cells, in their interior." ..... "The epithelial cytoblasts of internal parts present similar phenomena of growth, development, and metamorphosis to those of the exterior epidermis; they are seen on the lining membrane of the heart, in veins, on the chorion, the amnion, and on all mucous and serous surfaces." ..... "They constitute the first rudiment of the ovum, and the globules of blood, milk, and other animal fluids; they give origin to capillary vessels, to cartilage, to the fibres of the lens, of the teeth, of cellular tissue, of nerves, muscles, and most other tissues of animal bodies." (Grant, 'Outlines,' 1841, p. 643.)—"In all creatures above the protozoa, it would seem to be certain that their body proceeds from a mass of cells." (Kölliker, 1852.)

The endocystics also frequently originate, without formative plasma, free in the rich highly animalized fluids of living animals, after the manner of monadineans in infusions of organized matter. .... "New cells (says Dr. Car-

penter) are not unfrequently to be met with, especially in the nutritive fluids of such animals as possess a distinct circulation, which have not originated in either of these modes (of fissiparous generation) from a previously existing cell, but which have been developed by a process of *free* cell-formation, namely, by the aggregation of organic molecules, floating in these fluids, into little masses, of which the external particles coalesce into a membranous cell-wall, whilst the interior liquify into cell-contents." ('Microscope,' 1856, p. 464.) Even monadinean and epitrichous animalcules (entodinium, &c.) originate abundantly in this manner in the rich, warm, digesting, fluid aliments of quadrupeds; and have been described by many observers from the stomach and intestine of ruminating and pachydermatous mammalians; but these are never admissible into the circulating fluids, or capable of originating tissues like endocysties formed from the living plasma of the blood. Not only has the primitive elemental fluid origin of endocystics been thus familiar to early microscopists, but also the distinct independent animality of these organisms has been already perceived. Kölliker, in describing those of the brain, observes, "These cells, which must be considered to be endowed with peculiar vital powers, and to be capable of absorption and assimilation, of growth and of multiplication, not only at the earliest period, entirely compose the body of the higher and that of most of the lower animals, but almost wholly generate the higher elementary parts of the fully developed body." ('Histology,' 1852, vol. i. p. 14.)

The nourishment of animals being effected by the transmission of fluids through membranes, which exclude the nuclei and cells of food till dissolved, the endocystic nuclei originate only from fluids *within* the living body. And as they are only small particles of the formative plasma emanating from the living fluids, it is quite arbitrary to confine vitality and organization to any particular stage of the process of their formation from the fluid state. These first changes are molecular and fall within the domain of or-

ganic chemistry, which can now easily imitate artificially many, though not the whole, of their results. It is only when they have arrived at the definite and familiar protozoic forms of nuclei and cells, that they enter the domain of zoology. "The formation of cells (says Schwann) bears the same relation to organic nature that crystallization does to inorganic." Thus all animals and parts of animals originating *de novo* from their fluid elements, and passing through the conditions of liquor, plasma, nucleus, and cell, the dogma of Harvey, *omne vivum ex ovo*, suitable to the Evolution period, is now changed by the progress of microscopical investigation both in the vegetable and animal kingdom, to *nullum vivum ex ovo*, and a once-closed path is now thrown open to legitimate philosophic inquiry. The highly favourable conditions, as to congenial temperature, consistence of medium, presence of required organic elements and vital forces, tranquillity for undisturbed operation, protection for commencing development, &c., under which *endocystics* originate in the warm complex organisms of the highest animals, cannot be imitated in outward nature in the richest fluids of the globe; and their higher endowments and potentialities, thence acquired, are manifested in the phenomena of their future life, and in their developing all the tissues, normal and abnormal, and all the highest organisms which exist. Although here ranked only as an order, they form an immense class of animals, which appear to occupy this place in the scale of organized beings.

*First Suborder.* Histocystica, *Grant.*

Endocystics originating and inhabiting the soft or solid tissues of animal bodies.

Genera? *Osteocystion* (originating bone), *Myocystion* (originating muscle), *Chondrocystion* (originating cartilage), *Neurocystion* (originating nerve), &c.

*Second Suborder.* Hygrocystica, *Grant.*

Endocystics originating or inhabiting the normal fluids of animal bodies.

Genera? *Hemacystion* (blood corpuscle), *Myxocystion* (mucous corpuscle), *Galacystion* (milk corpuscle), &c. To assign definite names and a determinate place to the objects of nature, greatly facilitates their study and their description. And the continued systematic observation, study, and history of the normal and abnormal living phenomena of these remarkable microscopic independent organisms, which belongs to the modern branch of histology, physiological or pathological, promises to constitute a new and an important era in medical science.

## Third Order.

### MONADINEA, *Grant* (Monadina, *Ehr.*, *V. d. Hoeven*, &c. partim. Ectocystica, *Grant*).

Granulous, nuclear, or celliform, free, microscopic, simple or compound, aquatic animalcules, with or without nucleus; without chlorophyl, or cellulose lining; without mouth or anal opening; not formed from plasma in living animals, possessing power of locomotion, and always endowed with distinct independent power of assimilation, growth, and generation. Appearing at first as particles of albumen or gelatine, formed from their fluid organic elements in the infusions of vegetable or animal matter in the waters of the globe; never originating *ab ovo*, nor by the metamorphosis of pre-existing vegetable cells, but readily multiplying by fissiparous generation, and metamorphosing into an indefinite series of higher forms, as do also the protophytic germs of plants. The nearer the infusions realize all the conditions of the formative plasma of higher internal animal endocystics, the more readily and abundantly do they originate monadinean or ectocystic nuclei. But the richest infusion or the highest plasma never originates spontaneously a perfect adult animal, or saves one step of the ordinary series of developmental changes of the nuclei—art can merely favour the necessary conditions, not force nature in their formation. They originate from and assimilate only organized matter; but the protophytic cell assimilates

mineral elements, and organizes them to its simple tissues, which can thus form, feed, and endow the monadinean. Deep red carmine was seen to enter the nucleated sarcodous cell of spongilla, as into a monad. Like the endocystics, these ectocystics, or monadineans, are only the junior state of an indefinite series of higher organisms.

In their ordinary fissiparous generation, which is very frequently and rapidly effected, the nucleus and the cell-contents divide dichotomously often into many separate independent parts, which escape and develope on the investing sarcodous cell-wall dissolving away. The same dichotomous plan of division is seen in the endocystic ovum of many higher classes. The cell-contents and the whole body most generally divide transversely into two equal parts, often also longitudinally into two lateral halves, and Opulina was seen by Frey to divide transversely into three parts. In the multiple divisions of the same cell-contents, the sarcodous interior substance takes on the character of a plasma, and its parts the character of endocystics. And almost every other vital phenomenon seen in monadineans, is manifested also in the endocystic forms. The study of the monadineans, easy of access and easy to observe, explains many remarkable physiological appearances of endocystics, extremely difficult to trace in that order.

As the origination of monadineans in the mixed, foreign, fluid-contents of the alimentary canal of various animals, has been long familiarly known, the simple gregarinean cells found parasitic in the intestine of vertebrate and invertebrate animals, and the simple mycetozoic cells found parasitic in the human bronchi, might all be referred to the same monadinean order of Cystodes; and they are all equally with vegetable cells incapable of originating, like endocystics, the remarkably endowed tissues of higher animals—more nervous influence than they can furnish being required to effect the complex organic combinations manifested in the latter structures, and to endow them with the remarkable vital forces which thence result.

No animal can be formed by nature or art in its perfect state, *de novo* or even *ab ovo,* without its passing through the entire long series of developmental changes peculiar to each. Whether the product of the nucleus is to be a monad or a whale, each successive stage of the process of formation has within itself the sole and exclusive potentiality of the next stage in advance, and none therefore can ever be overstepped or omitted.

The mode of formation of the primitive nuclei of monadineans, as of endocystics, which, from the concurrent testimony of all observers, is never spontaneous, but by the slow union of their constituent molecules suspended in a fluid or viscid medium, will necessarily place these objects always on the verge of the invisibly minute, whatever improvements may tend to perfect the microscope; and, like the nebulæ of space on the confines of the invisibly remote, will make them subject to occasional errors of observation, to be rectified by succeeding observers. But, in themselves, these minute formative nuclei afford no special pretext for being made the cherished themes of hypotheses; and viewed with an inquiring and truthful spirit, the majesty of nature is not less apparent in the minutest than in the grandest of her works.

The notion still cherished by some, that every animal cell must have a preceding cell, is a lingering remnant of the pre-Wolffian evolution-hypothesis, equally supported by evidence, and not less useful and convenient to the views of its supporters. As the simple vegetable cell organizes only the simple binary elements of the mineral kingdom, contained in the atmosphere and the waters, to fit them and to endow them for the more elevated organism of the monad; so all the higher classes of plants and animals are similarly co-related, the lower grade organizing and endowing compounds suitable for the economy of the higher grade. And this law is beautifully manifested in the order of the organic relics of the successive strata composing the outer crust of the globe. The most varied forms of the lowest animals originate from monadineans by mere

metamorphoses and endless diversities in the modes of generation, the limits of which changes it is rarely possible to trace. The higher classes originate from endocystics more elaborately organized and more wonderfully endowed; the products therefore attaining a higher degree of complexity, the morphology is more uniform and with greater durability of type. The types of animals are the exponents of the conditions which have produced them, and no type has yet been observed—insect, mollusk, or vertebrate—which imperatively calls for any new laws or preternatural agencies for its mode of origin.

The nucleated granules of the living sarcode of acritoncura, ever moving and changing their forms, appear to be a mere aggregate of the independent nuclei and cells of monadincans. And the acritoneurose sarcode, so tenacious of vitality, is scarcely entirely used up in its differentiations to compose the many special organs for separate functions in higher classes. The mode of origination of the simple cell of the plant, from its constituent molecules, resembles that of the animal cell, monadincan or endocystic. Schleiden "found that in the formation of vegetable cells, small, sharply defined granules are first generated in a granulous substance, and around them the cell-nuclei (cytoblasts) are formed, which appear like granulous coagulations around the granules."

As the protophytic cell and the protozoic cell require no incomprehensible chemistry for their origination in nature's laboratory, as they are peculiarly fitted to originate a surface-film of organic matter on the spheres of space suited to maintain life, and as they have never ceased to be perspired from ours, their whole relations to each other and to the mineral kingdom, and the necessary physical conditions of their formation, have for more than a century been most thoroughly and satisfactorily investigated. But the recent discoveries of the conservation of the physical and the vital forces, which have added a new lustre to the scientific annals of England, and seem scarcely yet known on the Continent, have pointed out a new relation of the three kingdoms of

nature, or conditions of matter, to each other, which may pervade the universe.

The simple forces of gravitation, cohesion, and affinity characterizing the binary compounds of the mineral kingdom, are converted in the vegetable kingdom into complex chemical forces, effecting higher organic combinations, producing new and remarkable properties in the compounds, and eliciting vital phenomena, believed by some to belong to a class distinct from those of chemistry or physics. This highly prepared organized matter forms the food of the animal kingdom, where the accumulated, concentrated, and converted forces effect combinations, produce properties, and elicit phenomena of a more transcendent character, constituting the life of the highest organisms. These phenomena ceasing after a definite time, or death ensuing, the complex organic compounds return as binary elements with their simple forces, to the mineral kingdom; and the accumulated latent vital forces now set free, effect numerous combinations in surrounding matter, evolving gaseous and fluid products, and preparing protophytic and protozoic cells to commence the same round of molecular mutations—phenomena correlated, uniform, and simple in their plan, as in all nature's operations, but harmonious, universal, and grand in their results.

Gen. *Monas*, &c.

THE END.

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